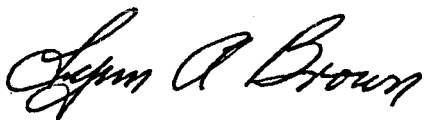
foreword

This soil survey contains information that can be used in land-planning programs in Lincoln County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

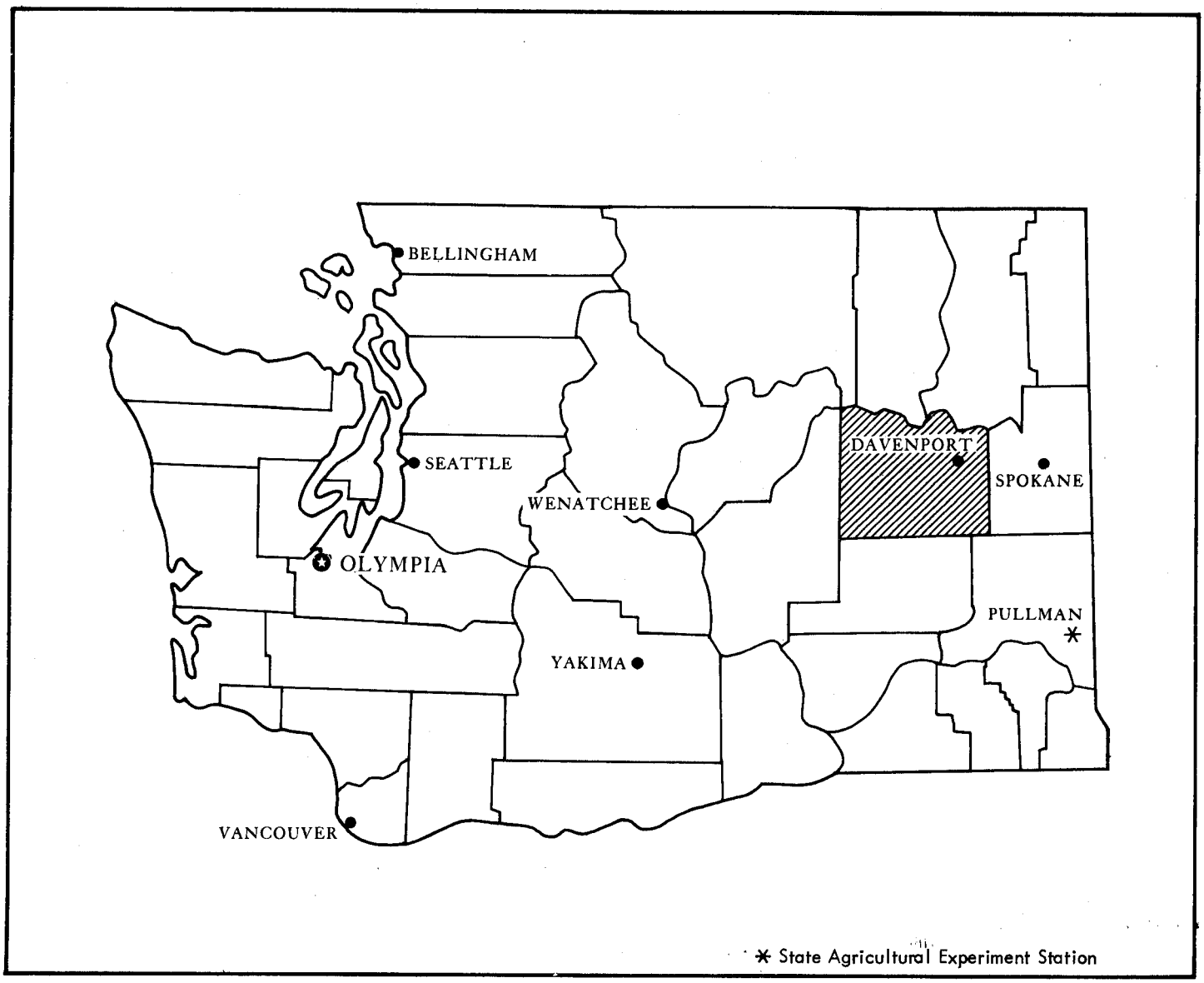
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and' specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



Lynn A. Brown
State Conservationist
Soil Conservation Service



Location of Lincoln County in Washington.

soil survey of
Lincoln County, Washington

By Dale D. Stockman

Fieldwork by Dale D. Stockman, Thomas E. Reedy, Michael W. Klungland Phillip D. McColley, and William R. Fibich, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service in cooperation with Washington State University Agricultural Research Center

LINCOLN COUNTY is in the east-central part of Washington. It has an area of 1,475,520 acres, or about 2,300 square miles. About 50 percent of the area is cultivated wheatland, about 40 percent is rangeland, and about 10 percent is grazable woodland.

The northern boundary of the county is a deep canyon cut by the Columbia and Spokane Rivers. The central part of the county consists of channeled scablands. The eastern, western, and southern parts of the county consist of nearly level to hilly uplands that are dissected by the channeled scablands. The elevation ranges from 1,290 feet, along Roosevelt Lake, to 3,568 feet, on Lilienthal Mountain. It increases about 25 feet per mile from the southwest to the northeast.

general nature of the survey area

This section gives general information about the survey area. It discusses history and development; climate; and physiography, relief, and drainage.

history and development

Before the first settlements on record were established, this survey area was the site of one of the most popular Indian trails in eastern Washington. Many of the Indians who used the trail camped by a spring where the town of Davenport is now.

The earliest settlers on record in this area were mostly fur traders, government freighters, or miners. The first of those settlers, Samuel Wilbur Condin ("Wild Goose Bill"), arrived in 1875. Many of the others arrived about 1880, when the establishment of Fort Spokane and the construction of the Northern Pacific Railroad created demand for hay, grain, and other commodities.

In 1883 the survey area, then part of Spokane County, became Lincoln County. Sprague was the county seat until 1895, when fire destroyed most of the town including the county courthouse and the division headquarters of the Northern Pacific Railroad. Davenport then became the county seat. Northern Pacific moved its headquarters to Spokane.

According to the most recent census, the county has a population of about 9,500.

Two railroads and two main highways, Interstate 90 and U.S. 2, serve the county. Airports in the towns of Davenport, Sprague, Wilbur, and Almira accommodate small aircraft. The nearest scheduled air service is at Spokane Municipal Airport.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The Rocky Mountains partly shield Lincoln County from strong arctic winds, so winters generally are not too severe, though cold. In summer the mountains block Pacific Ocean winds; days are hot but nights are fairly cool. In all areas except mountainous areas, precipitation is scant in summer; but in many of those areas it is adequate during the cooler parts of the year for

nonirrigated small grains or rangeland. The snowpack accumulation at high elevations supplies irrigation water for intensive agriculture in some lowland areas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Davenport and Odessa in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 28 degrees F at Davenport and 32 degrees at Odessa, and the average daily minimum temperature is 22 degrees at Davenport and 24 degrees at Odessa. The lowest temperature on record, which occurred at Odessa on January 26, 1957, is -24 degrees. In summer the average temperature is 65 degrees at Davenport and 69 degrees at Odessa, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Odessa on August 4, 1961, is 112 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 16 inches at Davenport and 10 inches at Odessa. Of this, 30 percent usually falls in April through September, which includes the growing season for most crops. The heaviest 1-day rainfall during the period of record was 1.44 inches at Davenport on June 24, 1958. Thunderstorms occur on about 10 days each year, and most occur in summer.

Average seasonal snowfall is 46 inches at Davenport and 18 inches at Odessa. The greatest snow depth at any one time during the period of record was 55 inches at Davenport and 19 inches at Odessa. On an average of 17 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 50 percent. Humidity is higher at night, and the average at dawn is about 75 percent. The sun shines 75 percent of the time possible in summer and 30 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 9 miles per hour, in spring.

physiography, relief, and drainage

Lincoln County encompasses four major physiographic areas: uplands, channeled scablands, canyons, and river terraces.

In the uplands, the slopes are nearly level to steep. The upland soils, for example the Bagdad, Broadax, and Hanning soils, formed in loess. They produce winter wheat and barley.

The channeled scablands are characterized by rough relief. They were formed as glacial meltwater intensively scoured loess-covered basalt bedrock. The dominant features are the channels, plateaus, and buttes. Along the channels are outwash terraces, bars, loess islands, and cataracts and basins. On the plateaus the relief is broken by patterned ground-circular mounds of loess surrounded by cobble-size fragments of basalt (3, 4). In about half of the scabland area, basalt is exposed at the surface; and in the rest of the area, a thin mantle of loess overlies basalt or glacial outwash. The scabland soils, for example the Anders and Benco soils, are used mainly as rangeland.

In the canyons are outcrops of dolomite bedrock and soils that formed in a mixture of loess and colluvium that derived mainly from granite, basalt, and quartzite. The soils are used as grazable woodland.

The terraces along the Columbia and Spokane Rivers are made up of sand and gravel deposited by the water. In some areas the sand has been reworked into a dunelike relief. The soils that formed in the sand and gravel, the Ewall, Phoebe, and Springdale soils for example, are used as grazable woodland.

An east-west ridge spanning the northern boundary of the county separates two drainage patterns. Drainage north of the ridge goes into the Columbia and Spokane Rivers. Drainage south of the ridge follows the scabland channels, from northeast to southwest. Corbett, Goose, Sinking, and Cannawai Creeks drain into Wilson Creek, which drains into Grant County. Marlin, Hollow Lake, Duck, Coal, and Bluestem Creeks drain into Crab Creek, which drains into Grant County also.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been, changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory, measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

Well drained soils that formed in loess; on uplands

This group consists of four map units. It makes up about 52 percent of the survey area. The soils in this group are nearly level to steep. The native vegetation is mainly grasses. The elevation is 1,200 to 3,000 feet. The average annual precipitation is 6 to 18 inches, the mean annual air temperature is about 49 degrees F, and the frost-free season is 110 to 170 days.

The soils in this group are moderately deep, very deep, and well drained. They formed in loess.

These soils are mainly used as nonirrigated cropland. Winter wheat is the main crop.

1. Shano-Burke

Nearly level to strongly sloping, very deep and moderately deep soils in 6- to 9-inch precipitation zone

This map unit is in the southwestern corner of Lincoln County. The soils are mainly nearly level to strongly sloping. They are on uplands at an elevation of 1,200 to 1,700 feet. The average annual precipitation is 6 to 9 inches, the mean annual temperature is 50 degrees F, and the average frost-free season is 130 to 170 days.

This map unit makes up about 2 percent of the survey area. It is about 50 percent Shano soils, 20 percent Burke soils, and 30 percent soils of minor extent.

The Shano soils are very deep. Typically, they are silt loam to a depth of 60 inches or more.

The Burke soils are moderately deep. Typically, they have a silt loam surface layer and substratum. A duripan is at a depth of 36 inches.

Of minor extent in this map unit are Esquatzel soils on bottom lands.

The soils in this map unit are used mainly as nonirrigated cropland. Winter wheat is the main crop. In a few areas these soils are sprinkler irrigated, with water from deep wells, for use as cropland.

The main limitation to the use of these soils as cropland is the hazard of erosion by wind and water. Because of the low annual precipitation, winter wheat is grown in alternate years with fallow to collect additional moisture.

2. Renslow-Ritzville

Nearly level to moderately steep, very deep soils *in 9- to 13-inch precipitation zone*

This map unit is in the southwestern part of Lincoln County. The soils are mainly nearly level to moderately steep. They are on uplands at an elevation of 1,300 to 2,400 feet. The average annual precipitation is 9 to 13 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 120 to 160 days.

This map unit makes up about 20 percent of the survey area. It is about 50 percent Renslow soils, 25 percent Ritzville soils, and 25 percent soils of minor extent.

The Renslow and Ritzville soils are on uplands. Typically, they are silt loam to a depth of 60 inches or more.

Of minor extent in this map unit are Farrell soils on terraces, Esquatzel soils on bottom lands, Willis soils on uplands, Willis Variant soils on south and west-facing slopes on uplands, and Emdent soils in basins.

The soils in this unit are used mainly as nonirrigated cropland. In places, they are sprinkler irrigated, with water from deep wells, for use as cropland. The main limitation to the use of these soils as cropland is the hazard of water erosion where the slope is more than 5 percent.

3. Bagdad

Nearly level to steep, very deep soils in 12- to 15-inch precipitation zone

This map unit is in the central, northwestern and southeastern parts of Lincoln County. The soils are mainly nearly level to steep. They are on uplands at an elevation of 1,600 to 2,800 feet. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the average frost-free season is 110 to 150 days.

This map unit makes up about 21 percent of the survey area. It is about 80 percent Bagdad soils, 10 percent Endicott soils, and 10 percent soils of minor extent.

The Bagdad soils are very deep. Typically, they are silt loam to a depth of 60 inches or more.

The Endicott soils are moderately deep. They are on south- and east-facing slopes. Typically, the surface layer and the subsoil are silt loam. The substratum consists of silt loam and a lime-silica cemented duripan, which is at a depth of 30 inches.

Of minor extent in this map unit are Anders soils on basalt plateaus, Benge and Chard soils on terraces, and Onyx soils on bottom lands.

The soils in this map unit are used as nonirrigated cropland. The main limitation to this use is the hazard of water erosion where the slope is more than 7 percent.

4. Broadax-Hanning

Nearly level to steep, very deep soils in 15- to 18-inch precipitation zone

This map unit is in the eastern part of Lincoln County. The soils are mainly nearly level to steep. They are on uplands at an elevation of 2,200 to 3,000 feet. The average annual precipitation is 15 to 18 inches, the mean annual air temperature is about 48 degrees F, and the average frost-free season is 120 to 150 days.

This map unit makes up about 11 percent of the survey area. It is about 50 percent Broadax soils, 40 percent Hanning soils, and 10 percent soils of minor extent.

The Broadax and Hanning soils are very deep. Typically, they are silt loam to a depth of 60 inches or more.

Of minor extent in this map unit are Lance soils on south-facing slopes on uplands and Mondovi soils on bottom lands.

The soils in this map unit are used as nonirrigated cropland. The main limitation to this use is the hazard of water erosion where the slope is more than 7 percent.

Well drained soils that formed in loess over basalt, and Rock outcrop; on basalt plateaus

This group consists of 3 map units. It makes up about 39 percent of the survey area. The soils in this group are nearly level to strongly sloping. The native vegetation is mainly grasses. The elevation is 1,300 to 2,500 feet. The average annual precipitation is 9 to 18 inches, the mean annual air temperature is about 49 degrees F, and the average frost-free season is 90 to 160 days.

The soils in this group are moderately deep or very shallow and are well drained. They formed in loess over basalt.

In most areas the soils are used as rangeland. In a few areas they are used as nonirrigated cropland.

5. Roloff-Bakeoven-Rock outcrop

Nearly level to strongly sloping, moderately deep and very shallow soils in 9- to 12-inch precipitation zone, and Rock outcrop

This map unit is in the western part of Lincoln County. It is mainly on basalt plateaus. The elevation is 1,300 to 1,700 feet. The average annual precipitation is 9 to 12 inches, the mean annual air temperature is about 50 degrees F, and the average frost-free season is 120 to 160 days.

This map unit makes up about 15 percent of the survey area. It is about 35 percent Roloff soils, 20 percent Bakeoven soils, 15 percent Rock outcrop, and 30 percent soils of minor extent.

The Roloff soils are moderately deep. Typically, they have a silt loam surface layer and subsoil. Basalt is at a depth of 23 inches.

The Bakeoven soils are very shallow. Typically, they have a very cobbly loam surface layer and subsoil. They are underlain by basalt at a depth of 5 inches.

In areas of Rock outcrop, 90 percent of the surface is exposed basalt bedrock. Most of the areas are nearly level and gently sloping. Some are escarpments 50 feet high.

Of minor extent in this map unit are Beckley, Strat, and Stratford soils on terraces and terrace escarpments. Also of minor extent are Emdent soils in basins and Starbuck soils on plateaus along major drainageways.

The soils in this map unit are used mainly as rangeland. They are also used as nonirrigated cropland; and in a few areas they are sprinkler irrigated for hay and pasture. The use of the soils in this map unit as sites for dwellings with basements and as septic tank absorption fields is limited mainly by the shallowness to basalt. The main limitations of these soils for use as rangeland are their shallowness to basalt and low available water capacity. The outcrops of basalt limit the use of machinery.

6. Anders-Bakeoven-Rock outcrop

Nearly level to moderately steep, moderately deep and very shallow soils in 12- to 16-inch precipitation zone, and Rock outcrop

This map unit is mainly in the central part of Lincoln county. It is mainly on basalt plateaus. The elevation is 1,600 to 2,500 feet. The average annual precipitation is 12 to 16 inches, the mean annual air temperature is about 51 degrees F, and the average frost-free season is 120 to 160 days.

This map unit makes up about 18 percent of the survey area. It is about 30 percent Anders soils, 15

percent Bakeoven soils, 15 percent Rock outcrop, and 40 percent soils of minor extent.

The Anders soils are moderately deep. Typically, they have a silt loam or gravelly silt loam surface layer and a silt loam subsoil that is underlain by fractured basalt at a depth of 28 inches.

The Bakeoven soils are very shallow. Typically, they have a very cobbly loam surface layer and subsoil. Basalt is at a depth of 5 inches.

In areas of Rock outcrop, 90 percent of the surface is exposed basalt bedrock. Most of the areas are nearly level and gently sloping. Some are escarpments 50 feet high.

Of minor extent in this map unit are Benge and Benco soils on terraces and terrace escarpments, Cocolalla and Emdent soils in basins, and Kuhl soils on canyon breaks along major drainageways.

The soils in this map unit are used mainly as rangeland. They are also used as nonirrigated cropland, and in a few areas they are sprinkler irrigated for hay and pasture.

The use of the soils in this map unit as sites for dwellings with basements and as septic tank absorption fields is limited mainly by the shallowness to basalt. The main limitation of these soils for use as rangeland are their shallowness to basalt and low available water capacity. The outcrops of basalt limit the use of machinery.

7. Tucannon-Rock outcrop

Nearly level to strongly sloping, moderately deep soils in 15 to 18-inch precipitation zone, and Rock outcrop

This map unit is in the eastern part of Lincoln County. It is mainly on basalt plateaus. The elevation is 1,500 to 2,500 feet. The average annual precipitation is 15 to 18 inches, the mean annual air temperature is about 48 degrees F, and the average frost-free season is 90 to 140 days.

This map unit makes up about 4 percent of the survey area. It is about 50 percent Tucannon soils, 20 percent Rock outcrop, and 30 percent soils of minor extent.

Typically, the Tucannon soils have a silt loam surface layer and subsoil. Basalt is at a depth of 30 inches.

In areas of Rock outcrop, 90 percent of the surface is exposed basalt bedrock. Most of the areas are nearly level and gently sloping. Some are escarpments 50 feet high.

Of minor extent in this map unit are Benco, Cheney, and Hesseltine soils on terraces, Dragoon soils on uplands near buttes, Kuhl soils along major drainageways, and Cocolalla soils on bottom lands and in basins.

The soils in this map unit are used mainly as rangeland. They are also used as nonirrigated cropland. Ponderosa pine is scattered in a few areas.

The use of the soils in this map unit as sites for dwellings with basements and as septic tank absorption fields is limited mainly by the depth to basalt. The main limitations of these soils for use as rangeland are their depth to basalt and low available water capacity. The outcrops of basalt limit the use of machinery.

Soils on canyon slopes, plateaus, and river terraces, and Rock outcrop

This group consists of two map units. It makes up about 9 percent of the survey area. The soils in this group are nearly level to steep. They are on terraces and canyon slopes along the Columbia and Spokane Rivers. The native vegetation is mainly grasses, forbs, shrubs, and conifers. The elevation is 1,300 to 3,000 feet. The average annual precipitation is 12 to 24 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free season is 100 to 180 days.

The soils in this group are very shallow to very deep and well drained to excessively drained. They formed in glacial outwash and loess over basalt and granite.

These soils are used as grazable woodland and as rangeland.

8. Badge-Bakeoven-Rock outcrop

Steep, very deep and very shallow, well drained soils on canyon slopes and plateaus, and Rock outcrop

This map unit is along the northern edge of Lincoln County. It is mainly on steep canyon slopes draining into the Columbia and Spokane Rivers. The elevation is 1,400 to 3,000 feet. The average annual precipitation is 12 to 20 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free season is 100 to 140 days.

This map unit makes up about 7 percent of the survey area. It is about 20 percent Badge soils, 20 percent Bakeoven soils, 10 percent Rock outcrop, and 50 percent soils of minor extent.

The Badge soils are very deep. They formed in a mixture of colluvium that derived from basalt and loess on canyon slopes. Typically, the surface layer is very cobbly silt loam. The subsoil is extremely gravelly silt loam. The substratum is extremely gravelly loam to a depth of 60 inches or more.

The Bakeoven soils are very shallow. They are on plateaus. These soils formed in loess over basalt. Typically, they have a very cobbly loam surface layer and subsoil. Basalt is at a depth of 5 inches.

In areas of Rock outcrop, 90 percent of the surface is exposed bedrock. Most of the bedrock is basalt, but some is granite or quartzite. In some places, the outcrops are escarpments 50 feet high.

Of minor extent in this map unit are Anders soils on basalt plateaus, Dragoon soils on uplands and buttes, Kuhl soils along major drainageways, Speigle soils on north-facing canyon slopes, and Spokane soils on foot slopes of the Columbia and Spokane watersheds.

The soils in this map unit are used mainly as rangeland. They are also used as grazable woodland.

The main limitations of these soils for use as rangeland are shallowness to basalt and low available water capacity. The cobblestones, outcrops of bedrock, and steepness of slope limit the use of machinery.

9. Ewall-Springdale

Nearly level to steep, very deep, excessively drained and somewhat excessively drained soils on river terraces

This map unit is along the northern boundary of Lincoln County. It is mainly on terraces of the Columbia and Spokane Rivers. The elevation is 1,300 to 3,000 feet. The average annual precipitation is 12 to 20 inches, the mean annual air temperature is about 47 degrees F, and the average frost-free season is 110 to 180 days.

This map unit makes up about 2 percent of the survey area. It is about 65 percent Ewall soils, 20 percent Springdale soils, and 15 percent Rock outcrop and soils of minor extent.

The Ewall soils are excessively drained. They formed in outwash sand on terraces and side slopes of terraces. Typically, a thin layer of needles and twigs covers the surface layer, which is loamy sand. The underlying material is sand to a depth of 60 inches or more.

The Springdale soils are somewhat excessively drained. They formed in glacial outwash on terraces. Typically, the surface layer is gravelly or cobbly sandy loam. The underlying material is very gravelly loamy coarse sand and sand to a depth of 60 inches or more.

Of minor extent in this map unit are Phoebe soils on terraces, Spokane. soils on foot slopes, Nespelem soils on dissected terraces, and Rock outcrop.

In most areas of this map unit the soils are used as grazable woodland. In a few areas they are used as nonirrigated cropland but only to establish grass and legume pasture. The main limitations to the use of these soils as woodland are cobbles on the surface and loose footing, which hinder the use of machinery. The steepness of slope in some areas also hinders the use of machinery. Seedling mortality is a severe hazard on the Springdale soils.

broad land use considerations

The soils of Lincoln County vary widely in their potential for major land use. Approximately 50 percent of the land in the county is cultivated cropland, and the main crop is winter wheat. This cropland is in map units 1, 2, 3, and 4. It consists mainly of Shano, Renslow, Ritzville, Bagdad, Broadax, and Hanning soils. The low annual precipitation in map units 1 and 2 limits the cropping system to alternate years of winter wheat and fallow. With intensive management, the soils in map unit 3 are used for a three year rotation of winter wheat, spring barley, and fallow. The soils in map unit 4 are used for annual cropping of wheat and barley. The main limitation in map units 1, 2, 3, and 4 is the hazard of water erosion.

Approximately 40 percent of the land in the county is rangeland. This rangeland is in map units 5, 6, and 7. It consists mainly of Roloff, Anders, Tucannon, Benge, Stratford, and Bakeoven soils. The main limitations are the low available water capacity and depth to bedrock. Rock outcrops make tillage difficult on these units.

About 10 percent of the land in the county is grazable woodland. Ponderosa pine is the dominant tree species in map units 8 and 9. The major soils supporting are Badge, Ewall, and Springdale soils. Use of equipment is limited by stones on the surface layer, loose footing, steepness of slope, and Rock outcrop.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up *a soil series.* Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Bagdad silt loam, 0 to 7 percent slopes, is one of several phases in the Bagdad series.

Some map units are made up of two or more major soils. These map units are called *soil complexes.* In a complex the soils are in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Bagdad-Endicott silt loams, 7 to 25 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

1-Anders silt loam, 0 to 5 percent slopes. This is a moderately deep and well drained soil on basalt plateaus. It formed in loess over fractured basalt. The elevation is 1,600 to 2,500 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 120 to 150 days.

Typically, the surface layer is dark grayish brown silt loam 12 inches thick. The subsoil is pale brown silt loam 16 inches thick. Fractured basalt is at a depth of 28 inches. The depth to basalt ranges from 20 to 40 inches. In places, the slope is more than 5 percent.

Included in mapping are Benge soils on terraces, Emdent and Cocolalla soils in basins, and outcrops of basalt. These inclusions make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as nonirrigated cropland. In a few small areas it is used as rangeland or is sprinkler irrigated for cropland, hay, and pasture. Winter wheat, barley, grass, and alfalfa are the principal crops. The main limitation to the use of this soil as cropland or rangeland is the moderate depth to basalt, which limits the available water capacity of the soil.

Commonly the cropping system consists of winter wheat and fallow; winter wheat, spring barley, and fallow; or alfalfa and grass followed by fallow and grain. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-

slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough crop residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Level terraces can be used to intercept excess surface water. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This soil is well suited to use as rangeland (fig. 1). The potential native vegetation is bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. Big sagebrush and threetip sagebrush are also included. The range deteriorates if the proportion of the bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grass drill or a grain drill.

The use of this soil as septic tank absorption fields and building sites is limited mainly by the depth to basalt. This map unit is in capability subclass IIIe, nonirrigated.

2-Anders gravelly silt loam, 0 to 15 percent slopes. This is a moderately deep, well drained soil on basalt plateaus. It formed in loess over fractured basalt. The elevation is 1,600 to 2,500 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 120 to 150 days.

Typically, the surface layer is dark grayish brown gravelly silt loam 12 inches thick. The subsoil is pale brown gravelly silt loam 16 inches thick. Fractured basalt is at a depth of 28 inches. The depth to basalt ranges from 20 to 40 inches. In some areas the surface layer is cobbly.

Included in mapping are outcrops of basalt, Benge soils on terraces, Kuhl soils on plateaus and canyon

Figure 1.-This Loamy-2 range site in an area of Anders silt loam, 0 to 5 percent slopes, is in excellent condition.

breaks, and Emdent soils in basins. These inclusions make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. In a few small areas it is used as rangeland or is sprinkler irrigated for cropland, hay, and pasture. Winter wheat, grass, and alfalfa are the principal crops. The moderate depth to basalt, which limits the available water capacity of the soil is the main limitation to the use of this soil as cropland and rangeland.

Commonly, the cropping system consists of winter wheat and fallow or a combination of alfalfa and grass followed by fallow and grain. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, early seeding of fall grain, and stripcropping or divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough crop residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to control erosion. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This soil is well suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. Big sagebrush and threetip sagebrush are also included. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grass drill or a grain drill.

The use of this soil as septic tank absorption fields and as sites for buildings is limited mainly by the depth to basalt.

This map unit is in capability subclass IVe, nonirrigated.

3-Anders-Bakeoven-Rock outcrop complex, 0 to 15 percent slopes. This complex is on basalt plateaus in the channeled scablands (fig. 2). The soils formed in loess over basalt. The elevation is 1,600 to 2,500 feet. The native vegetation is mainly grasses and forbs; ponderosa pine is scattered in the Teleford area. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 120 to 150 days.

Anders silt loam, 0 to 15 percent slopes, makes up about 40 percent of this complex; Bakeoven very cobbly loam, 0 to 7 percent slopes, makes up 25 percent; and Rock outcrop makes up 20 percent. Included soils make up the rest.

Included in mapping are Kuhl soils on canyon breaks, Emdent and Cocolalla soils in basins, and Benge soils on terraces. Also included are areas of Anders soil on circular mounds more than 40 inches deep to basalt and some areas where the soil is underlain by very gravelly sand. The included soils make up about 15 percent of this complex:

The Anders soil is moderately deep and well drained. It formed in loess over fractured basalt. Typically, the surface layer is dark grayish brown silt loam 12 inches thick. The subsoil is pale brown silt loam 16 inches thick.

Fractured basalt is at a depth of 28 inches. The depth to basalt ranges from 20 to 40 inches.

Permeability of the Anders soil is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is slow, and the hazard of erosion is slight.

The Bakeoven soil is very shallow and well drained. Typically, the surface layer is brown very cobbly loam 2 inches thick. The subsoil is brown very cobbly loam 3 inches thick. It is underlain by basalt. The depth to basalt ranges from 4 to 10 inches.

Permeability of the Bakeoven soil is moderately slow. The available water capacity is very low. The effective rooting depth is 4 to 10 inches. Surface runoff is rapid, and the hazard of erosion is high.

In areas of Rock outcrop, 90 percent of the surface is exposed basalt. Most areas of the Rock outcrop are nearly level and gently sloping. Some are escarpments 50 feet high.

The soils in this complex are used as rangeland. The shallowness to basalt, which limits the available water capacity of the soil, is a limitation to this use. On the Anders soil the potential native vegetation is bluebunch wheatgrass, Idaho fescue, and big sagebrush or threetip sagebrush. On the Bakeoven soil the potential native vegetation is Sandberg bluegrass and stiff sagebrush. The range deteriorates if the proportion of bluebunch wheatgrass, Sandberg bluegrass, and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush on the Anders soil. This soil can be seeded with a drill if the range has deteriorated.

This complex is in capability subclass VIIs, nonirrigated.

4-Badge-Bakeoven-Rock outcrop complex, very steep. This complex is on canyon slopes that drain into the Columbia and Spokane Rivers (fig. 3). The slope is 25 to 55 percent. The elevation is 1,500 to 2,600 feet. The native vegetation is grasses. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 110 to 140 days.

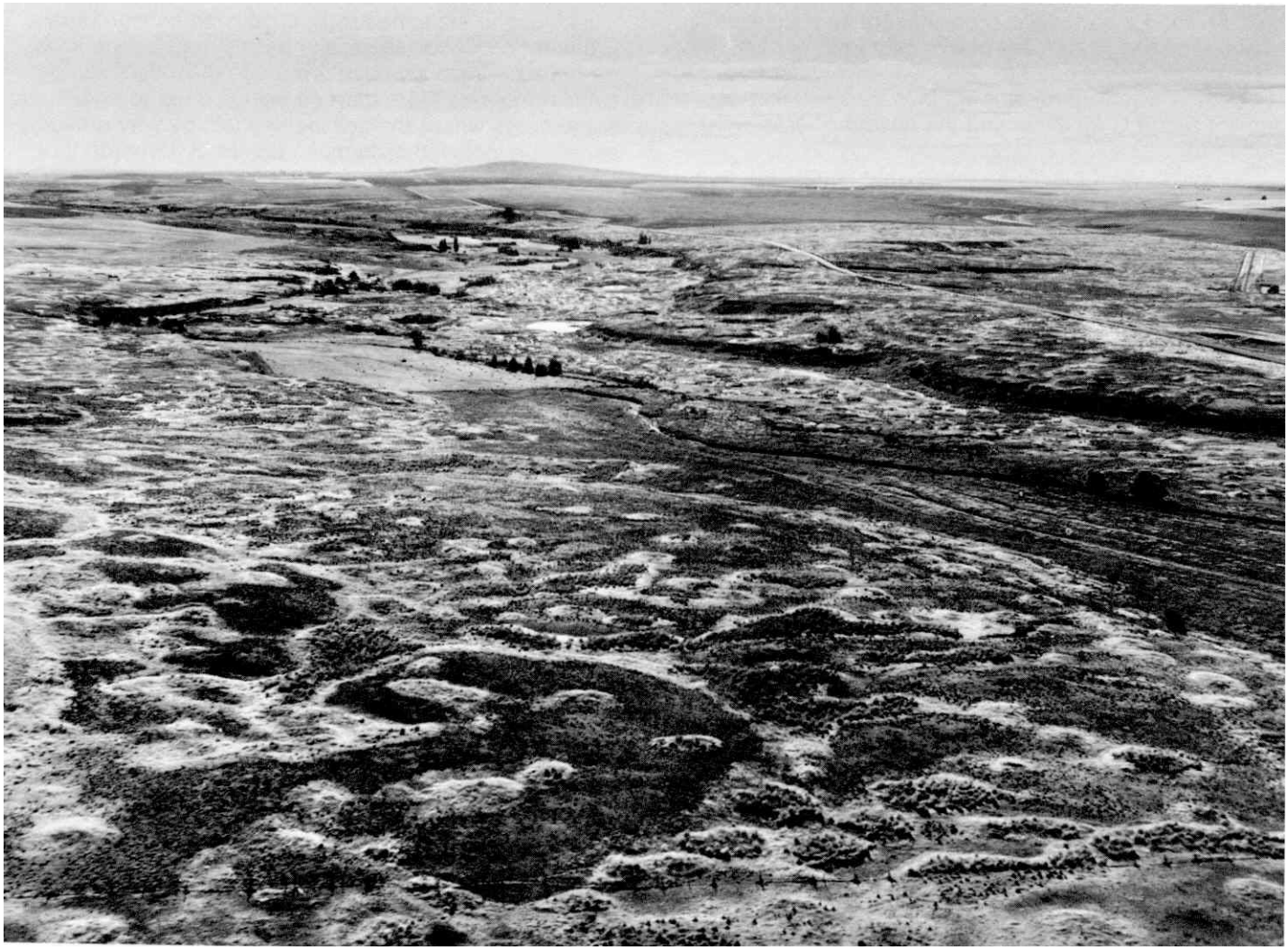


Figure 2.-Anders-Bakeoven-Rock outcrop, 0 to 15 percent slopes, is in the center and foreground of this area of the channeled scablands.

Badge very cobbly silt loam, 25 to 55 percent slopes, makes up about 40 percent of this complex; Bakeoven very cobbly loam, 0 to 25 percent slopes, makes up 25 percent; and Rock outcrop makes up 20 percent.

Included in mapping are soils that do not have coarse fragments in the surface layer, soils that have slope of less than 25 percent, soils that do not have an argillic horizon, and soils that contain lenses of volcanic ash. These included soils make up about 10 percent of this complex. Also included, and making up about 5 percent of this complex, are areas of talus.

The Badge soil is very deep and well drained. It formed in a mixture of colluvium that derived from basalt and loess. Typically, the surface layer is dark grayish brown and dark brown very cobbly silt loam 18 inches thick. The subsoil is brown extremely gravelly silt loam and extremely gravelly loam about 16 inches thick. The substratum is brown extremely gravelly loam to a depth of 60 inches.

Permeability of the Badge soil is moderately slow. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

The Bakeoven soil is very shallow and well drained. It formed in loess over basalt. Typically, the surface layer is brown very cobbly loam 2 inches thick. The subsoil is brown very cobbly loam 3 inches thick. It is underlain by basalt. The depth to basalt ranges from 4 to 10 inches.

Permeability. of the Bakeoven soil is moderately slow. The available water capacity is very low. The effective rooting depth is 4 to 10 inches. Surface runoff is rapid, and the hazard of erosion is high.

In areas of Rock outcrop 90 percent of the surface is exposed basalt. Most of the areas are escarpments 10 to 50 feet high.

The soils in this complex are used as rangeland. The very steep slopes and the cobbly surface layers, which limit the use of machinery, are limitations to this use. On the Bakeoven soil, the shallowness to basalt, which limits the available water capacity of the soil, is a limitation also. The potential native vegetation is bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush for the Badge soil and Sandberg bluegrass and stiff sagebrush for the Bakeoven soil. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range.

This complex is in capability subclass VIIs, nonirrigated.

5-Bagdad silt loam, 0 to 7 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 110 to 140 days.

Typically, the surface layer is dark grayish brown and brown silt loam 14 inches thick. The subsoil is pale brown silt loam 23 inches thick. The substratum is yellowish brown silt loam to a depth of 60 inches. Carbonate accumulations are at a depth of 37 inches. In some places, the slope is more than 7 percent.

Included in mapping are soils that have a surface layer more than 20 inches thick and soils that have carbonate accumulations at a depth of more than 43 inches. These soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more.

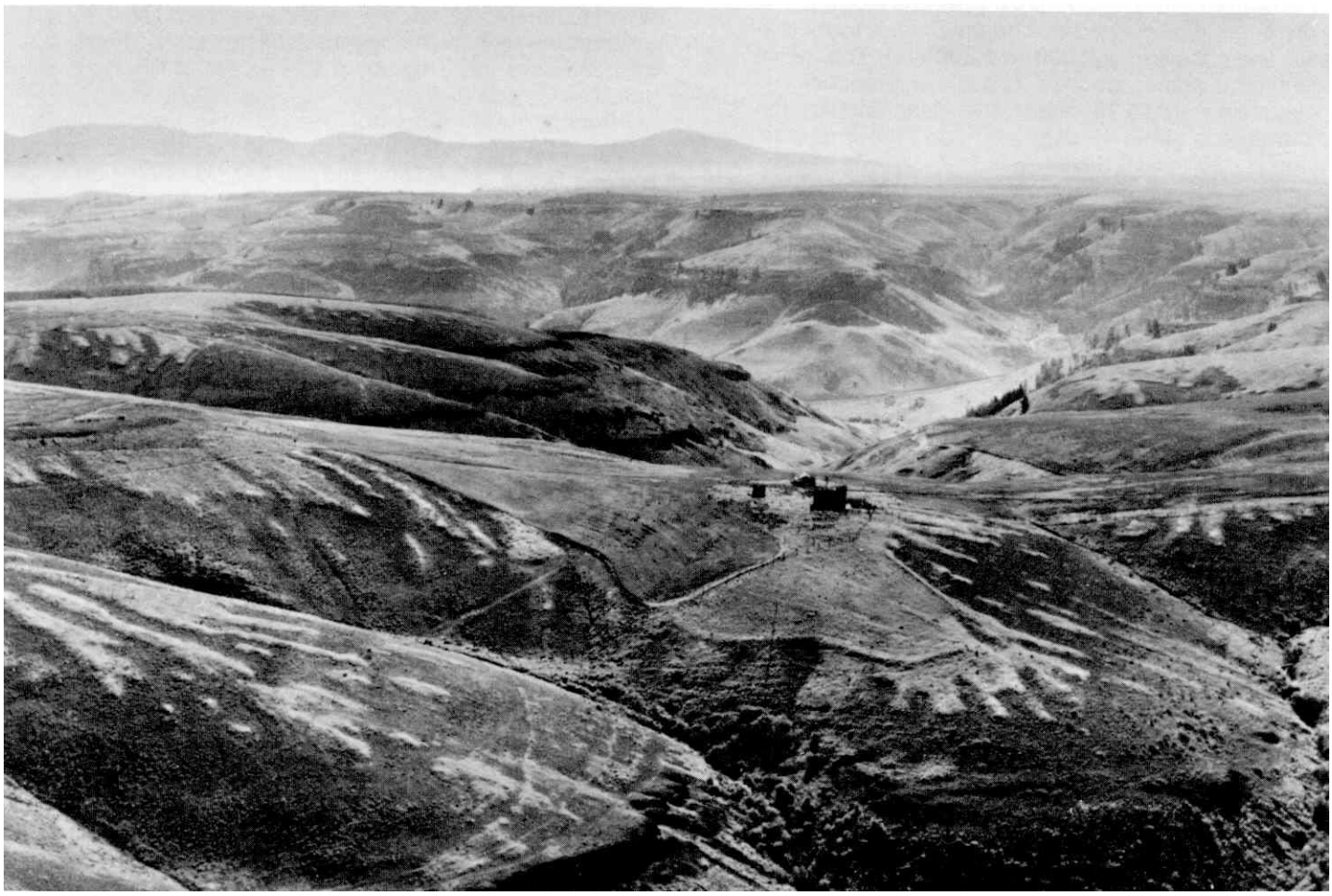


Figure 3.-Badge-Bakeoven-Rock outcrop complex, very steep, is on side slopes in most of the watershed area of the Columbia River. Bagdad silt loam, 7 to 25 percent slopes, is along the ridgetops.

Surface runoff is slow, and the hazard of erosion is slight.

This soil is used as nonirrigated cropland. There are few limitations to this use. Winter wheat, barley, grass, and alfalfa are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, and divided-slope farming reduce loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Level terraces can be used to intercept excess surface water. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This soil is well suited to use as homesites and septic tank absorption fields.

This map unit is in capability subclass IIe, nonirrigated.

6-Bagdad silt loam, 7 to 25 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 110 to 140 days.

Typically, the surface layer is dark grayish brown and brown silt loam 14 inches thick. The subsoil is pale brown silt loam 23 inches thick. The substratum is yellowish brown silt loam to a depth of 60 inches. Carbonate accumulations are at a depth of 37 inches. In some places, the slope is less than 7 percent.

Included in mapping are soils that have a surface layer more than 20 inches thick, Endicott soils on south-facing exposures, Anders soils on plateaus, and Benge soils on terraces in the channeled scablands. Soils that have cobbles in the surface layer are along drainageways. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as nonirrigated cropland. The main limitation to this use is the hazard of erosion. Winter wheat, barley, grass, and alfalfa are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

The use of this soil as homesites and septic tank absorption fields is limited mainly by the slope.

This map unit is in capability subclass IIIe, nonirrigated.

7-Bagdad silt loam, 7 to 25 percent slopes, eroded. This is a very deep, well drained soil on south- and southeast-facing slopes on uplands. It formed in loess. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 110 to 140 days.

Typically, the surface layer is dark grayish brown silt loam 8 inches thick. The subsoil is pale brown silt loam 16 inches thick. The substratum is yellowish brown silt loam to a depth of 60 inches. Carbonate accumulations are at a depth of 24 inches. In some areas along drainageways the surface layer is as much as 10 percent cobbles.

Included in mapping are Endicott soils on south- and east-facing slopes, Anders soils on plateaus, and Benge soils on terraces in the channeled scablands. These included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is high. About 50 percent of the original surface layer has been removed by erosion.

This soil is used as nonirrigated cropland. The main limitation to this use is the hazard of erosion. Winter wheat, barley, grass, and alfalfa are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

The use of this soil as homesites and septic tank absorption fields is limited mainly by the slope.

This map unit is in capability subclass IVe, nonirrigated.

8-Bagdad silt loam, 25 to 40 percent slopes. This is a very deep, well drained soil on slightly concave, north-facing slopes on uplands. It formed in loess. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses, forbs, and small shrubs. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost free season is 110 to 140 days.

Typically, the surface layer is dark grayish brown and brown silt loam 14 inches thick. The subsoil is pale brown silt loam 23 inches thick. The substratum is yellowish brown silt loam to a depth of 60 inches. Carbonate accumulations are at a depth of 37 inches. In some areas the slope is more than 40 percent.

Included in mapping are severely eroded soils on knobs and Broadax and Endicott soils along south-facing ridges. These included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. The surface runoff is rapid, and the hazard of erosion is high.

This soil is used as nonirrigated cropland. The main limitation to this use is the hazard of erosion. Winter wheat, spring barley, grass, and alfalfa are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. Where the slope is more than 40 percent, seeding permanent grass and alfalfa helps to reduce erosion. The crops respond to nitrogen fertilizer.

Slope is the main limitation to the use of this soil as septic tank absorption fields and as homesites.

This map unit is in capability subclass IVe, nonirrigated.

9-Bagdad-Endicott silt loams, 7 to 25 percent slopes. This complex is on uplands. The soils formed in loess. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 110 to 150 days.

Bagdad silt loam, 7 to 25 percent slopes, makes up about 60 percent of this complex; Endicott silt loam, 7 to 25 percent slopes, makes up about 30 percent; and included soils make up about 10 percent.

Included in mapping are areas where the soils are eroded and have caliche and accumulations of soft, powdery lime on the surface. Also included are some soils that have slope of more than 25 percent and some soils that have a surface layer that is more than 20 inches thick.

The Bagdad soil is very deep and well drained. It formed in loess on uplands. Typically, the surface layer is dark grayish brown and brown silt loam 14 inches thick. The subsoil is pale brown silt loam 23 inches thick. The substratum is yellowish brown silt loam to a depth of 60 inches. Carbonate accumulations are at a depth of 37 inches.

Permeability of this Bagdad soil is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

The Endicott soil is moderately deep and well drained. It formed in loess on south and east-facing slopes of the uplands. Typically, the surface layer is grayish brown silt loam 10 inches thick. The subsoil is brown silt loam 14 inches thick. The substratum is white silt loam in the upper 6 inches. Below that, it is a white, lime-silica cemented hardpan. The hardpan generally is at a depth of 20 to 40 inches. In places, it is at a depth of 10 to 20 inches.

Permeability of this Endicott soil is moderate above the hardpan and slow in the hardpan. The available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is high.

The soils in this complex are used as nonirrigated cropland. The major limitation to this use is the hazard of erosion. Winter wheat is the principal crop. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage,. chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This complex is in capability subclass IIIe, nonirrigated.

10-Bagdad-Endicott silt loams, 25 to 40 percent slopes. This complex is on uplands. The soils formed in loess. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 110 to 150 days.

Bagdad silt loam, 7 to 25 percent slopes, makes up about 60 percent of this complex; Endicott silt loam, 7 to 25 percent slopes, makes up 30 percent; and included soils make up 10 percent.

Included in mapping are areas where the soils are eroded and have fragments of caliche and accumulations of soft, powdery lime on the surface. Also included are soils that have a surface layer that is more than 20 inches thick.

The Bagdad soil is very deep and well drained. It formed in loess on uplands. Typically, the surface layer is dark grayish brown and brown silt loam 14 inches thick. The subsoil is pale brown silt loam 23 inches thick. The substratum is yellowish brown silt loam to a depth of

60 inches. Carbonate accumulations are at a depth of 37 inches.

Permeability of this Bagdad soil is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. The surface runoff is rapid, and the hazard of erosion is high.

The Endicott soil is moderately deep and well drained. It formed in loess on south and east-facing slopes on uplands. Typically, the surface layer is grayish brown silt loam 10 inches thick. The subsoil is brown silt loam 14 inches thick. The substratum is white silt loam in the upper 6 inches. Below that, it is a white lime- and silica-cemented hardpan. The hardpan generally is at a depth of 20 to 40 inches. In places, however, it is at a depth of 10 to 20 inches.

Permeability of this Endicott soil is moderate above the hardpan and slow in the hardpan. The available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is high.

The soils in this complex are used as nonirrigated cropland. The major limitation to this use is the hazard of erosion. Winter wheat is the principal crop. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling the stubble in fall, contour tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. In the included areas of eroded soils, a cover of grass can reduce further erosion. The grass should not be grazed for two years after seeding. The crops respond to nitrogen fertilizer.

This complex is in capability subclass IVe, nonirrigated.

11-Bakeoven very cobbly loam, 0 to 7 percent slopes. This is a very shallow, well drained soil on plateaus. It formed in loess over basalt. The elevation is 1,700 to 2,600 feet. The native vegetation is mainly grasses. The average annual precipitation is 10 to 16 inches, the mean annual temperature is about 52 degrees F, and the frost-free season is 110 to 160 days.

Typically, the surface layer is brown very cobbly loam 2 inches thick. The subsoil is brown very cobbly loam 3 inches thick. It is underlain by basalt. The depth to basalt ranges from 4 to 10 inches.

Included in mapping are Kuhl soils on breaks along major drainageways, outcrops of basalt, and Kuhl soils that have a surface layer of coarse sandy loam. These inclusions make up about 10 percent of this map unit.

Permeability is moderately slow. The available water capacity is very low. The effective rooting depth is 4 to 10 inches. Surface runoff is rapid, and the hazard of erosion is high.

This soil is used as rangeland. The shallowness to basalt, which limits the available water capacity of the soil, is a limitation to this use. The cobbles in the surface layer limit the use of machinery.

The potential native vegetation is stiff sagebrush and Sandberg bluegrass. The range deteriorates if the proportion of the Sandberg bluegrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range.

This map unit is in capability subclass VIIs, nonirrigated.

12-Beckley fine sandy loam, 0 to 7 percent slopes. This is a very deep, somewhat excessively drained soil on terraces. It formed in outwash. The elevation is 1,500 to 2,000 feet. The native vegetation is grasses and forbs. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 135 to 150 days.

Typically, the surface layer is dark grayish brown and dark brown fine sandy loam 12 inches thick. The subsoil is yellowish brown sandy loam 6 inches thick. The substratum is yellowish brown sandy loam 6 inches thick over brown coarse sand that extends to a depth of 60 inches or more. In places, the surface layer is very fine sandy loam and silt loam. In places, the slope is more than 7 percent.

Included in mapping are areas of Benge soils on terraces, soils that have cobbles and stones in the surface layer, and outcrops of basalt. These inclusions make up about 10 percent of this map unit.

Permeability is moderately rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight. Wind erosion is a moderate hazard.

This soil is used as nonirrigated cropland and as rangeland. In some small areas it is sprinkler irrigated for hay and pasture. The hazard of wind erosion is the main limitation to these uses.

Winter wheat and barley are the principal crops. The crops are commonly grown in a cropping system consisting of wheat or barley and fallow or a combination of alfalfa and grass followed by fallow and winter wheat. Stubble-mulch tillage, chiseling the stubble ground in fall, cross-slope tillage, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce wind and water erosion. Stripcropping at right angles to the prevailing wind or seeding permanent grass can reduce wind erosion. Sprinkler irrigation can increase crop yield. All crops respond to nitrogen fertilizer.

This soil is suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass,

needleandthread, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated.

This map unit is in capability subclass IIIe, nonirrigated.

13-Beckley fine sandy loam, 25 to 55 percent slopes. This is a very deep, somewhat excessively drained soil on terrace breaks. It formed in outwash. The elevation is 1,500 to 2,000 feet. The native vegetation is grasses and forbs. The average annual precipitation is 12 to 17 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 135 to 150 days.

Typically, the surface layer is dark grayish brown and dark brown fine sandy loam 12 inches thick. The subsoil is yellowish brown sandy loam 6 inches thick. The substratum is yellowish brown sandy loam in the upper 6 inches. Below that, to a depth of 60 inches or more, it is brown coarse sand. In places, the surface layer is sandy loam and the depth to coarse sand is 10 to 22 inches. In these places, gravel makes up as much as 15, percent of the profile.

Included in mapping are Bakeoven and Kuhl soils on plateaus and soils that have cobbles and stones in the surface layer. These included soils make up about 10 percent of this map unit.

Permeability is moderately rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is high. Wind erosion is a moderate hazard.

This soil is used as rangeland. The main limitation to this use is the hazard of wind erosion. The potential native vegetation is bluebunch wheatgrass, needleandthread, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Sandberg bluegrass decreases and the proportion of less desirable plants increases.. Proper grazing use and deferred-rotation grazing in spring in alternate years are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated. The use of chemicals and burning can control brush.

This map unit is in capability subclass VIe, nonirrigated.

14-Benco cobbly silt loam, 0 to 7 percent slopes. This is a very deep, well drained soil on terraces. It formed in glacial outwash material that is mixed with loess in the upper part. The elevation is 1,900 to 2,500 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 12 to 18 inches, the mean annual temperature is about 52 degrees F, and the frost-free season is 120 to 160 days.

Typically, the surface layer is grayish brown cobbly silt loam 10 inches thick. The subsoil is pale brown very cobbly silt loam 10 inches thick. The substratum is extremely gravelly loamy coarse sand to a depth of 60 inches or more. In places, the depth to gravelly loamy coarse sand is more than 20 inches.

Included in mapping are soils that have a very stony surface layer, outcrops of basalt, Anders and Kuhl soils on plateaus, and Benge soils on terraces. These inclusions make up about 10 percent of this map unit.

Permeability is moderately rapid to a depth of 20 inches and very rapid below that depth. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as rangeland. The coarse-textured substratum, which limits the available water capacity of the soil, is a limitation to this use. The cobbles in the surface layer interfere with the use of machinery.

The potential native vegetation is bluebunch wheatgrass, Idaho fescue and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This soil is suited to use as homesites. This use is limited mainly by large stones. If this soil is used as septic tank absorption fields, ground water pollution is a hazard because of the very rapid permeability of the substratum.

This map unit is in capability subclass VIs, nonirrigated.

15-Benge silt loam, 0 to 15 percent slopes. This is a very deep, well drained soil on terraces in the channeled scablands. It formed in glacial outwash and the overlying loess in the upper part. The elevation is 1,900 to 2,400 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 52 degrees F, and the frost-free season is 135 to 160 days.

Typically, the surface layer is dark grayish brown silt loam about 11 inches thick. The subsoil is brown gravelly silt loam 7 inches thick. The substratum is pale brown gravelly silt loam in the upper 7 inches. Below that to a depth of 60 inches or more, it is extremely gravelly loamy coarse sand. In places, the depth to loamy coarse sand is more than 40 inches.

Included in mapping are Anders soils on plateaus and Emdent and Cocolalla soils in basins. Also included are soils that have gravel, cobbles, and stones in the surface layer, outcrops of basalt, and soils that have slope of more than 15 percent. The inclusions make up about 15 percent of the map unit.

Permeability is moderate above the loamy coarse sand part of the substratum and very rapid in that part. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as nonirrigated cropland and as rangeland. In a few small areas it is sprinkler irrigated for hay and pasture. The coarse-textured substratum, which limits the available water capacity of the soil, is a limitation to these uses. Winter wheat and barley are the principal crops.

The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring wheat, or barley, and fallow; or alfalfa and grass followed by fallow and grain. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, and divided-slope farming increase water retention and reduce erosion. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Level terraces can be used to intercept excess surface water. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This soil is well suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of the bluebunch wheatgrass and Idaho. fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grass drill or a grain drill.

This soil is well suited to use as homesites. If this soil is used as septic tank absorption fields, ground water pollution is a hazard because of the very rapid permeability of the substratum in the lower part.

This map unit is in capability subclass IIIe, nonirrigated.

16-Broadax silt loam, 0 to 7 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,200 to 3,000 feet. The native vegetation is grasses, forbs, and shrubs. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown and dark brown silt loam 16 inches thick. The subsoil is yellowish brown silt loam 19 inches thick. The substratum is pale brown and brown silt loam to a depth of 60 inches. In some areas the slope is more than 7 percent.

Included in mapping are soils that have a silty clay loam surface layer. Also included are Hanning soils on broad ridgetops and Mondovi soils on bottomlands. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used as nonirrigated cropland. Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. The hazard of erosion is the main limitation to the use of this soil as cropland. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Level terraces can be used to intercept excess surface water. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIe, nonirrigated.

17-Broadax silt loam, 7 to 25 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,200 to 3,000 feet. The native vegetation is grasses, forbs, and shrubs. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown and dark brown silt loam 16 inches thick. The subsoil is yellowish brown silt loam 19 inches thick. The substratum is pale brown and brown silt loam to a depth of 60 inches. In some areas this soil has slope of less than 7 percent and may have secondary lime at a depth of 15 to 31 inches.

Included in mapping are soils that have lime and fragments of caliche in the surface layer. These soils are on short, moderately steep ridges. Also included are Hanning soils on broad ridgetops, Mondovi soils on bottom lands, and soils that do not have lime at a depth above 40 inches. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as nonirrigated cropland. The major limitation to this use is the hazard of erosion.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a

cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; and winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, divided-slope farming, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

18-Broadax silt loam, 25 to 40 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,200 to 3,000 feet. The native vegetation is grasses, forbs, and shrubs. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown and dark brown silt loam 16 inches thick. The subsoil is yellowish brown silt loam 19 inches thick. The substratum is pale brown and brown silt loam to a depth of 60 inches. In some places, the slope is more than 40 percent.

Included in mapping are Lance soils along the ridges that have north-facing exposures, soils that have a surface layer of silty clay loam, and Hanning soils. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

This soil is used as nonirrigated cropland. The main limitation to this use is the hazard of erosion.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. Where the slope is more than 40 percent, seeding to permanent grass and alfalfa helps to reduce erosion. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IVe, nonirrigated.

19-Broadax silt loam, low rainfall, 7 to 25 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,200 to 3,000 feet. The native vegetation is grasses, forbs, and shrubs. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 48 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown and brown silt loam 16 inches thick. The subsoil is yellowish brown silt loam 19 inches thick. The substratum is pale brown and brown silt loam to a depth of 60 inches. In places, the slope is less than 7 percent.

Included in mapping are soils that have a silty clay loam surface layer, soils that do not have carbonate accumulations above a depth of 60 inches, and, on north-facing exposures, soils that have slope of more than 25 percent. Also included are Dragoon soils on buttes. Some of these Dragoon soils have a surface layer of up to 10 percent coarse fragments. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitations to this use are the hazard of erosion and the limited effective precipitation.

Winter wheat, barley, grass, and alfalfa are the principal crops. Commonly, the cropping system consists of wheat and fallow. With intensive management, a three year rotation of winter wheat, spring barley or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

20-Broadax-Lance silt loams, 7 to 25 percent slopes. This complex is on uplands. The soils formed in loess. The elevation is 2,200 to 3,000 feet. The native vegetation is mainly grasses, forbs, and shrubs. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the average frost-free season is 120 to 160 days.

Broadax silt loam, 7 to 25 percent slopes, makes up 60 percent of this complex, and Lance silt loam, 7 to 25 percent slopes, makes up about 30 percent. Included soils make up the rest.

Included in mapping are soils that have a surface layer that is silty clay loam and contains carbonate accumulations. Also included are Hanning soils on uplands.

The Broadax soil is very deep and well drained. Typically, the surface layer is dark grayish brown and

dark brown silt loam 16 inches thick. The subsoil is yellowish brown silt loam 19 inches thick. The substratum is pale brown and brown silt loam to a depth of 60 inches. Secondary lime is at a depth of 31 inches. In places, the lime is at a depth of less than 31 inches, and the surface layer is more than 20 inches thick.

Permeability of the Broadax soil is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

The Lance soil is very deep and well drained. It formed in calcareous loess. Typically, the surface layer is pale brown silt loam 8 inches thick. The next layer is very pale brown silt loam about 14 inches thick. It contains lime-silica cemented durinodes. Below that layer, to a depth of 60 inches, there is a buried subsoil consisting of very pale brown silt loam. In places, the surface layer contains fragments of lime- and silica-cemented durinodes; and in some places, it contains soft, powdery lime.

Permeability of the Lance soil is moderately slow. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

The soils in this complex are used as nonirrigated cropland. The main limitation to this use is the hazard of erosion.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops commonly are grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, divided-slope farming, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This complex is in capability subclass IVe, nonirrigated.

21-Broadax-Lance silt loams, 25 to 40 percent slopes. This complex is on uplands. The soils formed in loess. The elevation is 2,200 to 3,000 feet. The native vegetation is mainly grasses, forbs, and shrubs. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the average frost-free season is 120 to 160 days.

Broadax silt loam, 25 to 40 percent slopes, makes up about 60 percent of this complex, and Lance silt loam, 25 to 40 percent slopes, makes up about 30 percent.

Included in mapping are soils that have a surface layer of silty clay loam, soils that do not contain accumulations of lime, and Hanning soils on uplands. Also included are Reardan soils along ridgetops. The included soils make up about 10 percent of this complex.

The Broadax soil is very deep and well drained. Typically, the surface layer is dark grayish brown and dark brown silt loam 16 inches thick. The subsoil is yellowish brown silt loam 19 inches thick. The substratum is pale brown and brown silt loam to a depth of 60 inches. In places, the surface layer is calcareous.

Permeability of the Broadax soil is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

The Lance soil is very deep and well drained. It formed in calcareous loess. Typically, the surface layer is pale brown silt loam 8 inches thick. The next layer is very pale brown silt loam 14 inches thick. It contains lime-silica cemented durinodes. Below that layer, to a depth of 60 inches, there is a buried subsoil consisting of very pale brown silt loam. In places, the surface layer contains fragments of lime-silica cemented durinodes; and in some places, it contains soft, powdery lime.

Permeability of the Lance soil is moderately slow. The available water capacity is moderate. The effective rooting depth is about 60 inches. Surface runoff is rapid, and the hazard of erosion is high.

The soils in this complex are used as nonirrigated cropland. The hazard of erosion is the main limitation to this use.

Winter wheat and barley are the principal crops. The crops are commonly grown in a cropping system consisting of wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of grass and alfalfa followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Permanent seeding of perennial grass and alfalfa is the optimum measure for erosion control. The grass should be protected from grazing for two years after seeding.

These soils are well suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass and Idaho fescue. Big sagebrush and threetip sagebrush are also included. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Erosion is a main concern on the steeper soils that are overgrazed. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated. Seeding can be done with a grain drill.

This complex is in capability subclass VIe, nonirrigated.

22-Burke silt loam, 0 to 15 percent slopes. This is a moderately deep, well drained soil on broad uplands. It formed in loess. The elevation is 1,200 to 1,600 feet. The native vegetation is mainly grasses and forbs. The average annual precipitation is 6 to 9 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 135 to 165 days.

Typically, the surface layer is brown silt loam 8 inches thick. The underlying material consists of brown and

yellowish brown silt loam 28 inches thick and, below that, a duripan. The depth to the duripan ranges from 24 to 40 inches. In places, basalt is at a depth of 40 to 60 inches.

Included in mapping are Shano soils on uplands and Anders soils on basalt plateaus. Also included are soils that have a surface layer containing caliche fragments and soft powdery lime. The included soils make up about 10 percent of this map unit.

Permeability is moderate to the duripan and very slow in the pan. The available water capacity is moderate. The effective rooting depth is 24 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. In some areas it is sprinkler irrigated for use as cropland. The main limitation to this use is the hazard of erosion. Winter wheat is the principal crop. Due to low annual precipitation the cropping system consists of a rotation of wheat and fallow. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, and early seeding of fall grain reduce erosion and loss of soil moisture. Stripcropping at right angles to the prevailing wind helps reduce wind erosion. Including grass in the cropping system helps to maintain and improve tilth. Level terraces can be used to intercept excess surface water. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. The crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IVe, nonirrigated.

23-Chard silt loam, 0 to 15 percent slopes. This is a very deep, well drained soil on terraces along major drainageways. It formed in glacial outwash material and the overlying loess. The elevation is 1,800 to 2,000 feet. The native vegetation is grasses and forbs. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 135 to 160 days.

Typically, the surface layer is dark grayish brown silt loam in the upper 5 inches and dark grayish brown very fine sandy loam and dark brown silt loam in the lower 11 inches. The subsoil is dark yellowish brown very fine sandy loam 14 inches thick. The substratum is brown, calcareous sandy loam to a depth of 60 inches. In places, the sandy loam is at a depth of 10 to 20 inches.

Included in mapping is a similar soil, which is gravelly throughout. Benge and Benco soils on terraces are included in some areas. The included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion. Winter wheat is the principal crop. It is commonly grown in a cropping system consisting of wheat and fallow. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, divided-slope farming, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Level terraces can be used to intercept excess surface water. Including grass and alfalfa in the rotation helps to reduce erosion, increase fertility, and maintain or improve tilth. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

24-Cheney silt loam, 0 to 5 percent slopes. This is a very deep, well drained soil on terraces. It formed in glacial outwash that is mixed with loess in the upper part. The elevation is 1,900 to 2,300 feet. The native vegetation is mainly grasses. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown silt loam 11 inches thick. The subsoil is yellowish brown gravelly silt loam 14 inches thick. The substratum is light yellowish brown extremely gravelly loamy sand and extremely gravelly coarse sand to a depth of 60 inches. In places, the surface layer is up to 20 percent gravel and cobbles, and the slope is more than 5 percent.

Included in mapping are Benco soils on terraces and Tucannon and Kuhl soils on basalt plateaus. Also included are poorly drained Cocolalla soils and somewhat poorly drained Emdent soils in basins. The included soils make up about 15 percent of this map unit.

Permeability is moderate above the substratum and very rapid in the substratum. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a rotation consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Stubble mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and stripcropping reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the rotation reduce erosion, increase fertility, and maintain or improve tilth. Level terraces can be used to intercept excess surface water. All crops respond to nitrogen fertilizer.

This soil is well suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass, Idaho fescue, and rough fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This soil is well suited to use as homesites. If it is used as septic tank absorption fields, ground water pollution is a hazard because of the very rapid permeability of the substratum.

This map unit is in capability subclass IIIe, nonirrigated.

25-Cocolalla silt loam. This is a very deep, poorly drained soil on bottom lands and in basins in the channeled scablands. It formed in alluvium that derived from loess and volcanic ash. The slope is 0 to 3 percent. The elevation is 1,700 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 14 to 19 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 90 to 110 days.

Typically, the surface layer is dark gray silt loam 5 inches thick. The substratum is gray and light gray silt loam to a depth of 60 inches. In places, basalt is at a depth of 40 to 60 inches.

Included in mapping are Emdent soils in basins, areas of peat and muck, and areas that are ponded during most of the year. These included soils make up about 5 percent of this map unit.

Permeability is moderately slow. The available water capacity is high. The effective rooting depth is limited from December through May by an apparent water table, which is at the surface or at a depth of no more than 36 inches. Surface runoff is ponded, and the hazard of erosion is slight or none. Flooding is frequent from December through April.

This soil is used mainly as rangeland. The potential native vegetation is tufted hairgrass and sedge. Proper grazing use and deferred-rotation grazing in spring in alternate years are the most effective and the least expensive methods of improving the range.

This map unit is in capability subclass Vw, nonirrigated.

26-Cocolalla silt loam, drained. This is a deep soil in basins and on bottom lands in the channeled scablands. It formed in alluvium that derived from loess and volcanic ash. The slope is 0 to 3 percent. The elevation is 1,700 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 14 to 19 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 90 to 110 days.

Typically, the surface layer is dark gray silt loam 5 inches thick. The substratum is gray and light gray silt loam to a depth of 60 inches. In places, basalt is at a depth of 40 to 60 inches.

Included in mapping are Emdent soils in basins and soils that have a surface layer of up to 10 percent cobbles. These included soils make up about 5 percent of this map unit.

Permeability is moderately slow. The available water capacity is high. The effective rooting depth is 40 to 60 inches. Surface runoff is very slow, and the hazard of erosion is slight. Flooding is frequent from December through April. The seasonal high water table occurs at a depth of 3 to 5 feet.

This soil is used mainly as nonirrigated cropland. In some areas it is used as rangeland.

Spring barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of spring grain, grass, alfalfa, and fallow. Exesss water can damage seeded grain and delay the planting of spring grain. Flooding and siltation can be reduced along the drainages by protecting the streambank and by maintaining a permanent vegetative cover.

This soil is well suited to use as rangeland. The dominant native vegetation is tufted hairgrass and sedge. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range deteriorates. This soil can be seeded with a grain drill.

This map unit is in capability subclass IVw, nonirrigated.

27-Conconully very stony fine sandy loam, 25 to 55 percent slopes. This is a very deep, well drained soil on side slopes of canyons along the Columbia River. It formed in glacial till. The elevation is 1,500 to 3,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 11 to 15 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 130 to 150 days.

Typically, the surface layer is dark grayish brown and grayish brown very stony fine sandy loam 14 inches thick. The subsoil is brown gravelly sandy loam 26 inches thick. The substratum is pale brown and light yellowish brown gravelly sandy loam to a depth of 60 inches. In places, the slope is less than 25 percent.

Included in mapping are basalt outcrops, granite taluses, soils that are underlain by basalt at a depth of 40 to 60 inches, and soils that have a surface layer that is 10 to 15 percent angular, coarse fragments of basalt and granite. Also included, on terraces along the Columbia River, are soils that have a surface layer of loamy sand. The inclusions make up about 10 percent of this map unit.

Permeability is moderately rapid. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

This soil is used as rangeland. The steepness of slope and the large stones on the surface layer limit the use of machinery.

The potential native vegetation is bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Burning and the use of chemicals can control brush. Seeding is advisable if the range has deteriorated.

This map unit is in capability subclass VIIs, nonirrigated.

28-Dragoon silt loam, 0 to 7 percent slopes. This is a moderately deep, well drained soil on uplands. It formed in weathered granite and the overlying loess. The elevation is 2,300 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown and grayish brown silt loam in the upper 11 inches and brown loam in the lower 5 inches. The subsoil is light brown loam 7 inches thick. It is underlain by weathered granite at a depth of 23 inches. The depth to weathered bedrock ranges from 20 to 40 inches. In places, the slope is more than 7 percent.

Included in mapping are soils that are underlain by granite at a depth of 40 to 60 inches and soils that have a silty clay loam subsoil. Also included are Hanning soils on uplands. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 -inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The moderate depth to weathered granite, which limits the available water capacity of the soil, is a limitation to this use.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, seeding grain early in fall, cross-slope tillage, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Level terraces can be used to intercept excess surface water. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

29-Dragoon silt loam, 7 to 25 percent slopes. This is a moderately deep, well drained soil on uplands. It formed in weathered granite and the overlying loess. The elevation is 2,300 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown and grayish brown silt loam in the upper 11 inches and brown loam in the lower 5 inches. The subsoil is light brown loam 7 inches thick. It is underlain by weathered granite at a depth of 23 inches. The weathered bedrock generally is at a depth of 20 to 40 inches. In places, it is at a depth of more than 40 inches.

Included in mapping are Reardan and Hanning soils on uplands and Tucannon soils on basalt plateaus. These included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland and as grazable woodland. The hazard of erosion is the main limitation to these uses. The moderate depth to weathered granite, which limits the available water capacity of the soil, is a limitation also.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat may be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, stripcropping, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain or improve tilth.

Where this soil is used as grazable woodland, the dominant native range grasses are bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill in areas that have been cleared.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa pine the site index, based on a 100-year site curve, is 74. The culmination of the mean annual increment is 61 cubic feet at 45 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This map unit is in capability subclass IVe, nonirrigated.

30-Dragoon silt loam, 25 to 40 percent slopes. This is a moderately deep, well drained soil on north-facing slopes of uplands and buttes. It formed in weathered granite and the overlying loess. The elevation is 2,300 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown and grayish brown silt loam in the upper 11 inches and brown loam in the lower 5 inches. The subsoil is light brown loam 7 inches thick. It is underlain by weathered granite at a depth of 23 inches. The weathered bedrock generally is at a depth of 20 to 40 inches. In places, it is at a depth of more than 40 inches.

Included in mapping are outcrops of granite and areas of soils that have a surface layer that is about 10 percent stones and 10 percent cobbles. Also included are areas of soils that are eroded and have a surface layer of silty clay loam. The inclusions make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is high.

This soil is used as grazable woodland. The main limitation to this use is the hazard of erosion. The dominant native range grasses are bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill in areas that have been cleared.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa pine the site index, based on a 100-year site curve, is 74. The culmination of the mean annual increment is 61 cubic feet at 45 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This map unit is in capability subclass VIe, nonirrigated.

31-Dragoon very stony silt loam, 7 to 25 percent slopes. This is a moderately deep, well drained soil on uplands and buttes. It formed in weathered granite and the overlying loess. The elevation is 2,300 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown and grayish brown very stony silt loam in the upper 11 inches and brown loam in the lower 5 inches. The subsoil is light brown loam 7 inches thick. It is underlain by weathered granite at a depth of 23 inches. The depth to weathered bedrock ranges from 20 to 40 inches. In places, the surface layer does not contain stones, and the slope is more than 25 percent.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

Included in mapping are outcrops of granite and areas of soils that are underlain by granite at a depth greater than 40 inches. These inclusions make up about 10 percent of this map unit.

This soil is used as grazable woodland. The moderate depth to weathered granite, which limits the available water capacity of the soil, is a limitation to this use. The dominant native range grasses are bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Burning and the use of chemicals can control brush. Seeding is advisable if the range has deteriorated.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa pine the site index, based on a 100-year site curve, is 74. The culmination of the mean annual increment is 61 cubic feet at 45 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a serious hazard. Stones on the surface limit the use of machinery.

This map unit is in capability subclass VIs, nonirrigated.

32-Emdent silt loam. This is a very deep, somewhat poorly drained soil on bottom lands and in basins in the channeled scablands. It formed in a mixture of volcanic

ash and loess. The slope is 0 to 3 percent. The elevation is 1,500 to 2,400 feet. The native vegetation is salt-tolerant grasses. The average annual precipitation is 9 to 18 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is grayish brown silt loam 10 inches thick. The underlying material is light brownish gray silt loam 14 inches thick in the upper part and light gray silt loam and white very fine sandy loam in the lower part to a depth of 60 inches. The profile commonly is strongly alkaline in the upper part and moderately alkaline in the lower part. In places, the percent of volcanic ash is less than 60.

Included in mapping are poorly drained Cocolalla soils on bottom lands, soils that have stones and cobbles in the surface layer, and soils that are underlain by basalt at a depth of less than 60 inches. These included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is very slow, and the hazard of erosion is slight. Flooding is occasional from January to May. A seasonal high water table is at a depth of 1.5 to 3.0 feet from November to June.

This soil is used mainly as rangeland. It provides sites for waterholes for livestock, and it supports salt-tolerant plants for summer grazing.

The potential native vegetation is basin wildrye, saltgrass, and alkali cordgrass (fig. 4). The range deteriorates if the proportion of basin wildrye decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Salt accumulation in the soil is a limitation. Seeding of salt-tolerant species is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This map unit is in capability subclass VIw, nonirrigated.

33-Emdent silt loam, drained. This is a very deep soil on bottom lands in the channeled scablands. It formed in a mixture of volcanic ash and loess. The elevation is 1,500 to 2,400 feet. The native vegetation is

Figure 4.-In the area of Emdent silt loam in the center and foreground, basin wildrye, alkali cordgrass, and saltgrass have been cut for hay. Anders-Bakeoven-Rock outcrop complex, 0 to 15 percent slopes, is in the background.

salt-tolerant grasses. The average annual precipitation is 9 to 18 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is grayish brown silt loam 10 inches thick. The underlying material is light brownish gray silt loam 14 inches thick in the upper part and light gray silt loam and white very fine sandy loam in the lower part to a depth of 60 inches. This soil generally is moderately alkaline throughout. In places the surface layer is noncalcareous.

Included in mapping are outcrops of basalt, soils that are underlain by basalt at a depth of less than 60 inches, and soils that have cobbles and stones in the surface layer. These inclusions make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is more than 60 inches. Surface runoff is very slow, and the hazard of erosion is slight. Flooding is occasional from January to May. The water table is at a depth of 3 to 4 feet from November to June.

This soil is used as rangeland and nonirrigated cropland.

The potential native vegetation is basin wildrye, saltgrass, and alkali cordgrass. The range deteriorates if the proportion of desirable plants decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range.

This soil is suited to use as nonirrigated cropland. Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of wheat and fallow or a combination of alfalfa and grass followed by fallow and grain. Excessive cultivation leaves the surface layer powdery and, therefore, subject to wind erosion. Stripcropping at right angles to the prevailing wind and stubble-mulch tillage or seeding permanent grass can reduce wind erosion. A permanent vegetative cover provides optimum erosion control.

This map unit is in capability subclass IVw, nonirrigated.

34-Endicott silt loam, 5 to 25 percent slopes. This is a moderately deep, well drained soil on south- and east-facing slopes on uplands. It formed in loess. The elevation is 2,300 to 2,600 feet. The native vegetation is mainly grasses. The average annual precipitation is 12 to 15 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown silt loam 10 inches thick. The subsoil is brown silt loam 14 inches thick. The substratum is white silt loam in the upper 6 inches. Below that, it is a lime-silica cemented hardpan. The depth to the duripan ranges from 20 to 40 inches. In places, basalt is at a depth of less than 60 inches, and lime-silica cemented fragments are common throughout the profile.

Included in mapping are soils that are underlain by a duripan at a depth of more than 40 inches and soils that are eroded and have soft, powdery lime and fragments of caliche on the surface. Also included are Bagdad soils. The included soils make up about 10 percent of this map unit.

Permeability is moderate to the duripan and very slow in the pan. The available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is mainly used as nonirrigated cropland. The . main limitation to this use is the hazard of erosion.

Winter wheat and barley are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. With intensive management, a three year rotation of winter wheat, spring or spring wheat, and fallow is used. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Including grass and alfalfa in the cropping system reduces erosion, increases fertility, and maintains or improves tilth. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

35-Esquatzel silt loam. This is a very deep, well drained soil on bottom lands. It formed in alluvium that derived from loess. The slope is 0 to 2 percent. The elevation is 1,400 to 2,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 6 to 12 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam 10 inches thick. The underlying material is brown silt loam to a depth of 60 inches.

Included in mapping are soils that have a strongly alkaline surface layer, soils that are underlain by basalt at a depth of 40 to 60 inches, soils that are underlain by a discontinuous hardpan, and soils that contain alternate layers of coarse sand and gravel. These soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is very slow, and the hazard of erosion is none to slight. Flooding is rare and brief in March and April.

This soil is used mainly as nonirrigated cropland. Winter wheat is the principal crop. Commonly, the cropping system consists of winter wheat and fallow. Stubble-mulch tillage and chiseling the stubble in fall reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Including grass and alfalfa in the cropping system

reduces erosion, increases fertility, and maintains or improves tilth. Stripcropping at right angles to the prevailing wind reduces wind erosion. Sprinkler irrigation can increase crop yield. All crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIc, nonirrigated.

36-Ewall loamy sand, 0 to 15 percent slopes. This is a very deep, excessively drained soil on terraces along the Columbia and Spokane Rivers. It formed in outwash sand. The elevation is 1,300 to 1,500 feet. The native vegetation is mainly grasses and scattered conifers. The average annual precipitation is 12 to 18 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 145 to 180 days.

Typically, a 1-inch-thick mat of undecomposed needles and twigs overlies the surface layer, which is grayish brown loamy sand 6 inches thick. The underlying material is pale brown sand to a depth of 60 inches. In places, stratified lenses of gravel are in the underlying material.

Included in mapping are circular depressions that are high in content of volcanic ash and soils that have a surface layer containing stones, gravel, and cobbles. These inclusions make up about 10 percent of this map unit.

Permeability is very rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight. The hazard of wind erosion is high.

This soil is used mainly as woodland. It generally is not suitable for cultivation; however, it can produce a fairly good crop of alfalfa a few years after the plants are established. A few small areas are sprinkler irrigated for hay and pasture. The major limitations to the use of this soil as cropland are droughtiness and the hazard of wind erosion.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 78. The culmination of the mean annual increment is 66 cubic feet per acre at 40 years. The stands vary in density. In open stands, the productivity is less than the potential indicated by the site index. Loose footing limits the use of machinery. On exposed sites the high soil temperature during summer may limit survival of planted stock.

This map unit is in capability subclass VIe, nonirrigated.

37-Ewall loamy sand, 15 to 35 percent slopes. This is a very deep, excessively drained soil on terraces along the Columbia and Spokane Rivers. It formed in outwash sand. The elevation is 1,300 to 1,500 feet. The native vegetation is mainly grasses and scattered conifers. The average annual precipitation is 12 to 18 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 145 to 180 days.

Typically, a 1-inch-thick mat of undecomposed needles and twigs overlies the surface layer, which is grayish brown loamy sand 6 inches thick. The underlying material is pale brown sand to a depth of 60 inches. In places, the surface layer is gravelly and cobbly.

Included in mapping are outcrops of granite and dolomite and soils that have a surface layer containing stones. These inclusions make up about 15 percent of the map unit.

Permeability is very rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight. The hazard of wind erosion is high.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 78. The culmination of the mean annual increment is 66 cubic feet per acre at 40 years. Loose footing limits the use of machinery. On exposed sites the high soil temperature during summer may limit the survival of planted stock. A permanent vegetative cover is needed to protect this soil from wind erosion.

This map unit is in capability subclass VIe, nonirrigated.

38-Ewall loamy sand, 35 to 55 percent slopes. This is a very deep, excessively drained soil on side slopes of terraces along the Columbia and Spokane Rivers. It formed in outwash sand. The elevation is 1,300 to 1,500 feet. The native vegetation is mainly grass and scattered conifers. The average annual precipitation is 12 to 18 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 145 to 180 days.

Typically, a 1-inch-thick mat of undecomposed needles and twigs overlies the surface layer, which is grayish brown loamy sand 6 inches thick. The underlying material is pale brown sand to a depth of 60 inches. In places, the surface layer is gravelly and cobbly.

Included in mapping are outcrops of granite and dolomite and soils containing 2- to 6-inch-thick layers of cobbles and gravel. These inclusions make up about 10 percent of this map unit.

Permeability is very rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is high.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 78. The culmination of the mean annual increment is 66 cubic feet per acre at 40 years. The stands vary in density. In open stands, the productivity is less than the potential indicated by the site index. Loose footing limits the use of equipment. On exposed sites the high soil temperature during summer may limit the survival of planted stock. A permanent vegetative cover is needed to protect this soil from wind and water erosion.

This map unit is in capability subclass VIIe, nonirrigated.

39-Farrell fine sandy loam, 5 to 25 percent slopes. This is a very deep, well drained soil on terraces

and terrace fronts. It formed in glacial outwash sand that is mixed with loess in the upper part. The elevation is 1,500 to 2,100 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 51 degrees F, and the frost-free season is 135 to 160 days.

Typically, the surface layer is brown fine sandy loam 14 inches thick. The subsoil is pale brown very fine sandy loam 12 inches thick. The upper part of the substratum is pale brown coarse sandy loam 15 inches thick. The lower part of the substratum is light brownish gray and pale brown sand and coarse sand to a depth of 60 inches. In places, the surface layer is very fine sandy loam and is 10 to 20 percent gravel.

Included in mapping are outcrops of basalt and some areas of soils that have fine and medium sand below the surface layer. These inclusions make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate. The hazard of wind erosion is high.

This soil is used as nonirrigated cropland. The main limitation to this use is the hazard of erosion by wind and water.

Winter wheat and barley are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. Stubble mulch tillage, chiseling or subsoiling the stubble ground in fall, cross-slope tillage, and early seeding of fall grain reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion.. Wind stripcropping or seeding permanent grass can reduce: wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IIIe, nonirrigated.

40-Farrell very fine sandy loam, 0 to 5 percent slopes. This is a very deep, well drained soil on terraces. It formed in glacial outwash sand that is mixed with loess in the upper part. The elevation is 1,500 to 2,100 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 51 degrees F, and the frost-free season is 135 to 160 days.

Typically, the surface layer is brown very fine sandy loam 14 inches thick. The subsoil is pale brown very fine sandy loam 12 inches thick. The upper part of the substratum is pale brown coarse sandy loam 15 inches thick. The lower part is light brownish gray and pale brown sand and coarse sand to a depth of 60 inches. In places, the surface layer is 10 to 20 percent gravel, and the slope is more than 5 percent.

Included in mapping are soils that have a very strongly alkaline surface layer and Stratford soils on terraces. These included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion by water is moderate. The hazard of erosion by wind is high.

This soil is used mainly as nonirrigated cropland. The hazard of wind erosion is the main limitation to this use.

Winter wheat and barley are the principal crops. Commonly, the cropping system consists of winter wheat and fallow. Stubble-mulch tillage and chiseling the stubble in fall reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Level terraces can be used to intercept excess surface water. Wind stripcropping at right angles to the prevailing wind or seeding to permanent grass reduces wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IIIe, nonirrigated.

41-Hanning silt loam, 0 to 7 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,300 to 3,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown and brown silt loam 21 inches thick. The subsoil is brown, yellowish brown, and light yellowish brown silt loam 28 inches thick. The substratum is pale brown silt loam to a depth of 60 inches. In places, secondary carbonates are at a depth of 40 to 60 inches.

Included in mapping are soils that have slope of more than 7 percent, Broadax soils along the edges of the steeper slopes, and soils that have a surface layer less than 20 inches thick. These included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used as nonirrigated cropland. It has few limitations to this use.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a rotation consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley in the rotation. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, and seeding early in fall reduce erosion and loss of soil moisture. All crop residue should be

returned to the soils and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. Level terraces can be used to intercept any excess surface water. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIe, nonirrigated.

42-Hanning silt loam, 7 to 25 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 2,300 to 3,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 48 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown and brown silt loam 21 inches thick. The subsoil is brown, yellowish brown, and light yellowish brown silt loam 28 inches thick. The substratum is pale brown silt loam to a depth of 60 inches. In places, secondary carbonates are at a depth of 30 inches.

Included in mapping are Broadax and Reardan soils on short, eroded ridges on the uplands and Tucannon and Cheney soils on basalt plateaus. Also included are soils that have a surface layer less than 20 inches thick and soils that have slope of more than 25 percent. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a rotation consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and wheat. Spring wheat can be substituted for spring barley in the rotation. Stubble-mulch tillage, chiseling or subsoiling the stubble ground in fall, cross-slope tillage, divided-slope farming, and seeding early in fall reduce erosion and loss of soil moisture. Where concentrated runoff occurs in the drainageways, double seeding of fall grain or use of grassed waterways helps to reduce erosion. The grass and alfalfa in the cropping system control erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

43-Hesseltine silt loam, 0 to 15 percent slopes. This is a very deep, well drained soil on terraces in the channeled scablands. It formed in glacial outwash and the overlying loess. The elevation is 2,000 to 2,300 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 17 to 20 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 110 to 140 days.

Typically, a 1-inch-thick mat of partially decomposed needles and twigs overlies the surface layer, which is grayish brown and brown silt loam 7 inches thick. The upper part of the subsoil is brown silt loam 5 inches thick, and the lower part is brown very gravelly silt loam 8 inches thick. The substratum is very gravelly and extremely gravelly coarse sand to a depth of 60 inches or more. In places, the depth to coarse sand is more than 30 inches. In some places, the surface layer contains stones.

Included in mapping are outcrops of basalt, Tucannon soils on plateaus, Benco soils on terraces, and soils that have a gravelly surface layer. These inclusions make up about 10 percent of this map unit.

Permeability is moderate to a depth of 20 inches and very rapid below that depth. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is mainly used as grazable woodland. In some areas it is used as nonirrigated cropland. The coarse textured substratum, which limits the available water capacity of the soil, is a limitation to these uses. The hazard of erosion is a limitation also.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

In the grazable woodland the dominant native range grasses are bluebunch wheatgrass and Idaho fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill in areas that have been cleared.

Ponderosa pine is the most common tree on this soil. For ponderosa pine the site index, based on a 100-year site curve, is 76. The culmination of the mean annual increment is 63 cubic feet at 45 years. The stands vary in density; however, they commonly are open.

Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This soil is well suited to use as homesites. If it is used as septic tank absorption fields, ground water pollution is a hazard because of the very rapid permeability of the substratum.

This map unit is in capability subclass IIIe, nonirrigated.

44-Hesseltine very stony silt loam, 0 to 15 percent slopes. This is a very deep, well drained soil on terraces in the channeled scablands. It formed in glacial outwash and the overlying loess. The elevation is 2,000 to 2,300 feet. The native vegetation is grass and conifers. The average annual precipitation is 17 to 20 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 110 to 140 days.

Typically, a 1-inch-thick mat of partially decomposed needles and twigs overlies the surface layer, which is grayish brown and brown very stony silt loam 7 inches thick. The upper part of the subsoil is brown silt loam 5 inches thick, and the lower part is brown very gravelly silt loam 8 inches thick. The substratum is very gravelly and extremely gravelly coarse sand to a depth of 60 inches or more. In places, the surface layer is cobbly. In some places it does not contain stones.

Included in mapping are Tucannon soils on plateaus, soils underlain by coarse sands at a depth of more than 40 inches, and outcrops of basalt. These inclusions make up about 10 percent of this map unit.

Permeability is moderate to a depth of 20 inches and very rapid below that depth. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as grazable woodland. The main limitation to this use is the stoniness of the layer. The stones hinder the use of machinery. The dominant native range grasses are bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Burning and the use of chemicals can control brush. Seeding is advisable if the range has deteriorated.

Ponderosa pine is the most common tree on this soil. For ponderosa pine the site index, based on a 100-year site curve, is 76. The culmination of the mean annual increment is 63 cubic feet at 45 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This map unit is in capability subclass VIs, nonirrigated.

45-Kuhl cobbly silt loam, 0 to 15 percent slopes. This is a shallow, well drained soil on canyon breaks along major drainageways and on basalt plateaus. It formed in a mixture of loess and colluvium that derived from basalt. The elevation is 1,700 to 2,200 feet. The native vegetation is mainly grasses. The average annual precipitation is 12 to 18 inches, the mean annual temperature' is about 50 degrees F, and the frost-free season is 140 to 150 days.

Typically, the surface layer is grayish brown and brown cobbly silt loam 8 inches thick. The subsoil is brown cobbly silt loam 4 inches thick. It is underlain by basalt. The depth to basalt ranges from 10 to 20 inches. In places, the surface layer is very cobbly or very stony.

Included in mapping are outcrops of basalt, Anders soils on basalt plateaus, Bagdad soils on uplands, Bakeoven soils between the Rock outcrop and the Anders soils, and basaltic talus in steep areas. These inclusions make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is very low. The effective rooting depth is 10 to 20 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as rangeland. The shallowness to basalt, which limits the available water capacity of the soil, is a limitation to this use. The cobbles on the surface interfere with the use of machinery.

The potential native vegetation is bluebunch wheatgrass and Sandberg bluegrass. If the range deteriorates, the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding with a range drill is advisable if the range has deteriorated.

This map unit is in capability. subclass VIs, nonirrigated.

46-Lance silt loam, 7 to 25 percent slopes. This is a very deep, well drained soil on south-facing slopes on uplands. It formed in calcareous loess. The elevation is 2,500 to 2,800 feet. The native vegetation is mainly grasses. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 120 to 160 days.

Typically, the surface layer is pale brown silt loam 8 inches thick. The next layer is very pale brown silt loam 14 inches thick. It contains lime-silica cemented durinodes. Below that layer, to a depth of 60 inches or more, there is a buried subsoil consisting of very pale brown silt loam. In places, the surface layer has been leached of carbonates. In some places, the surface layer is silty clay loam.

Included in mapping are short slopes that have a gradient of more than 25 percent, Hanning and Broadax soils on uplands, and areas where erosion removed more than 75 percent of the surface layer, exposing substratum. These inclusions make up about 15 percent of this map unit.

Permeability is moderately slow. The available water capacity is moderate. The effective rooting depth is about 60 inches. Surface runoff is rapid, and the hazard of erosion is high. This soil is severely eroded.

This soil is used as nonirrigated cropland. The main limitations to this use are the hazard of erosion and a lack of organic matter.

Winter wheat, barley, and alfalfa are the principal crops. The crops are grown in a cropping system consisting of wheat and fallow; winter wheat, spring barley, and fallow; and grass or grass mixed with alfalfa, fallow, and winter wheat. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, and seeding early in fall reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Seeding to permanent grass and alfalfa reduces erosion, improves tilth, and increases fertility. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IVe, nonirrigated.

47-Mondovi silt loam. This is a very deep, well drained soil on bottom lands. It formed in alluvium that derived from loess. The slope is 0 to 3 percent. The elevation is 2,000 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 16 to 20 inches, the mean annual temperature is about 52 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown silt loam 7 inches thick. The underlying material is dark grayish brown silt loam to a depth of 60 inches or more.

Included in mapping are areas where the soil is moderately alkaline, areas where layers of volcanic ash are in the lower part of the profile, areas where the water table is at a depth of 40 to 60 inches, and areas where the soil is poorly drained. Also included are Hanning soils on nearly level uplands. These inclusions make up about 5 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is very slow, and the hazard of erosion is none to slight. Flooding is rare.

This soil is used as nonirrigated cropland. Frost may damage winter wheat late in spring.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Spring wheat may be substituted for spring barley. Where concentrated runoff occurs in the drainageways, double seeding of fall grain or use of grassed waterways helps to reduce erosion. Grassed waterways help reduce the cutting of channels where excess surface water collects. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain and improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIw, nonirrigated.

48-Nespelem silt loam, 3 to 15 percent slopes. This is a very deep, well drained soil on dissected terraces along the Columbia and Spokane Rivers. It formed in calcareous lake sediments and the overlying loess. The elevation is 1,300 to 2,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 120 to 135 days.

Typically, the surface layer is grayish brown silt loam in the upper 13 inches and grayish brown very fine sandy loam in the lower 4 inches. The subsoil is pale brown very fine sandy loam 8 inches thick. The substratum is pale brown silt loam in the upper 4 inches. Below that, to a depth of 60 inches, it is pale yellow silt loam and silty clay loam. In places, the surface layer is more than 20 inches thick. In some areas the slope is more than 15 percent.

Included in mapping are soils that have a surface layer of loamy sand. Also included are small, circular depressions high in content of volcanic ash. These inclusions make up about 10 percent of this map unit.

Permeability is moderately slow. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as nonirrigated cropland and as woodland. The hazard of erosion is a limitation to these uses.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of wheat and fallow; winter wheat, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, early seeding of fall grain, and stripcropping reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and legumes in the cropping system reduce erosion, increase fertility, and maintain or improve tilth.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 80. The culmination of the mean annual increment is 69 cubic feet per acre at 40 years. The stands vary in density. In open stands the productivity is less than the

potential indicated by the site index. On exposed sites the high soil temperature during summer is the main threat to planted stock. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This map unit is in capability subclass IIIe, nonirrigated.

49-Nespelem silt loam, 15 to 35 percent slopes. This is a very deep, well drained soil on dissected terraces along the Columbia and Spokane Rivers. It formed in calcareous lake sediments and the overlying loess. The elevation is 1,300 to 2,000 feet. The native vegetation is grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 120 to 160 days.

Typically, the surface layer is grayish brown silt loam in the upper 13 inches and grayish brown very fine sandy loam in the lower 4 inches. The subsoil is pale brown very fine sandy loam 8 inches thick. The substratum is pale brown silt loam in the upper 4 inches. Below that, to a depth of 60 inches, it is pale yellow silt loam and silty clay loam. In places, the surface layer is gravelly.

Included in mapping are outcrops of granite and basalt and soils that have cobbles and stones in the surface layer. These inclusions make up about 10 percent of this map unit.

Permeability is moderately slow. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

This soil is used as nonirrigated cropland and as woodland. The main limitations to these uses are the hazard of erosion and the slope.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and winter wheat. Stubble-mulch tillage, chiseling the stubble ground in fall, cross-slope tillage, early seeding of fall grain, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 80. The culmination of the mean annual increment is 69 cubic feet per acre at 40 years. The stands vary in density. In open stands the productivity is less than the potential indicated by the site index. On exposed sites the high soil temperature during summer is the main threat to planted stock. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This map unit is in capability subclass IVe, nonirrigated.

50-Nespelem silt loam, 35 to 45 percent slopes. This is a very deep, well drained soil on side slopes of terraces along the Spokane and Columbia Rivers. It formed in calcareous lake sediments and the overlying loess. The elevation is 1,300 to 2,000 feet. The native vegetation is grasses and conifers. The average annual precipitation is 15 to 18 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 120 to 160 days.

Typically, the surface layer is grayish brown silt loam in the upper 13 inches and grayish brown very fine sandy loam in the lower 4 inches. The subsoil is pale brown very fine sandy loam 8 inches thick. The substratum is pale brown silt loam in the upper 4 inches. Below that, to a depth of 60 inches, it is pale yellow silt loam and silty clay loam. In places, the surface layer is gravelly.

Included in mapping are outcrops of basalt and soils that have a calcareous surface layer. These inclusions make up about 5 percent of this map unit.

Permeability is moderately slow. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is very rapid, and the hazard of erosion is very high.

This soil is used as woodland. The main limitation to this use is the hazard of erosion.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 80. The culmination of the mean annual increment is 69 cubic feet per acre at 40 years. The stands vary in density. In open stands the productivity is less than the potential indicated by the site index. On exposed sites the high soil temperature during summer is the main threat to planted stock. In areas that have a heavy understory of cheatgrass, fire is a serious hazard.

This map unit is in capability subclass VIe, nonirrigated.

51-Onyx silt loam. This is a very deep, well drained soil on bottom lands. It developed in alluvium that derived from loess. The slope is 0 to 2 percent. The elevation is 1,700 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 12 to 16 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is grayish brown silt loam 23 inches thick. The underlying material is pale brown silt loam to a depth of 60 inches. In places, the surface layer is moderately alkaline. Some pedons have stratified lenses of very fine sandy loam and fine sandy loam.

Included in mapping are areas of poorly drained soils, areas of soils that have a high content of volcanic ash, and areas where there are less than 120 frost-free days. Also included are areas of Bagdad soils on uplands. The included areas make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is more than 60 inches. Surface runoff is ponded, and the hazard of

erosion is none to slight. Flooding is occasional and brief from January through April.

This soil is used as nonirrigated cropland. The flooding may damage crops.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and wheat. Spring wheat can be substituted for spring barley. Grassed waterways help to reduce the cutting of channels where excessive surface runoff occurs. Where concentrated runoff occurs in the drainageways, double seeding of fall grain or use of grassed waterways helps to reduce erosion. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIw, nonirrigated.

52-Patit Creek Variant silt loam. This is a very deep, well drained soil on bottom lands. It formed in alluvium that derived from a mixture of loess and fragments of basalt. The slope is 0 to 3 percent. The elevation is 2,000 to 2,800 feet. The native vegetation is mainly grasses and trees. The average annual precipitation is 16 to 20 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown silt loam in the upper 23 inches and cobbly loam in the lower 15 inches. The underlying material is brown very gravelly coarse sand to a depth of 60 inches. In places, the surface layer is cobbly and gravelly.

Included in mapping are Ewall soils along terraces. Also included are soils that have coarse sand at a depth of 20 to 40 inches. The included soils make up about 15 percent of this map unit.

Permeability is moderate to a depth of 38 inches and very rapid below that depth. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is very slow, and the hazard of erosion is none to slight. Flooding is occasional and brief from January through May.

This soil is used as nonirrigated cropland and as rangeland. The main limitations to these uses are flooding, channel cutting, and frost damage to crops in late spring.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; or winter wheat, spring barley, spring barley, and fallow. Spring wheat can be substituted for spring barley. Permanent grass and alfalfa are used for improved hay and pasture. The grass and alfalfa in the cropping system help prevent channel cutting, increase fertility, and maintain and improve tilth.

This soil is well suited to use as rangeland. The potential native vegetation is basin wildrye, bluebunch wheatgrass, and Idaho fescue. Aspen, cottonwood, and scattered ponderosa pine are along the drainageways. The range deteriorates if the proportion of basin wildrye, bluebunch wheatgrass, and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the least expensive and the most effective methods of improving the range. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This map unit is in capability subclass IIIw, nonirrigated.

53-Pedigo silt loam. This is a very deep, somewhat poorly drained soil on bottom lands. It formed in alluvium that derived from a mixture of loess and volcanic ash. The slope is 0 to 3 percent. The elevation is 1,500 to 2,400 feet. The native vegetation is mainly alkali-tolerant grasses. The average annual precipitation is 10 to 16 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 130 to 160 days.

Typically, the surface layer is grayish brown silt loam 22 inches thick. The underlying material is brown silt loam to a depth of 60 inches. In places, the surface layer is mildly alkaline.

Included in mapping are outcrops of basalt, soils that are high in content of volcanic ash, and soils that are underlain by basalt at a depth of 40 to 60 inches. Also included are well drained Onyx and Mondovi soils near the uplands. These inclusions make up about 5 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is very slow, and the hazard of erosion is none to slight. The seasonal high water table is at a depth of 2.5 to 5.0 feet from January through May. Flooding is occasional and long from November through May.

This soil is used as nonirrigated cropland and as rangeland. The main limitations to these uses are the flooding and the seasonal high water table.

Winter wheat, barley, and alfalfa are the principal crops. The crops. are commonly grown in a cropping system of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or grass and alfalfa followed by fallow or winter wheat. Spring wheat can be substituted for spring barley. Excess water dissolves the salts in the profile. As this water evaporates, the salts remain in the surface raising the sodium content of the soil and thus reducing crop growth. Continuous cropping reduces the amount of excess water. Including grass, and alfalfa in the cropping system reduces channel cutting by floodwater and removes excess moisture.

The potential native vegetation on the rangeland is basin wildrye and inland saltgrass. The range deteriorates if the proportion of desirable plants

decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the, range. Seeding alkali-tolerant grasses is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This map unit is in capability subclass IIIw, nonirrigated.

54-Phoebe sandy loam, 0 to 15 percent slopes. This is a very deep, well drained soil on terraces. It formed in glacial outwash. The elevation is 1,500 to 2,000 feet. The native vegetation is mainly grasses and some ponderosa pine. The average annual precipitation is 16 to 20 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 120 to 140 days.

Typically, the surface layer is dark grayish brown sandy loam 14 inches thick. The subsoil is brown fine sandy loam 9 inches thick. The substratum is brown sandy loam in the upper 23 inches. Below that, to a depth of 60 inches, it is yellowish brown loamy sand. In places, basalt is at a depth of 40 to 60 inches.

Included in mapping are soils that have rock fragments in the surface layer, outcrops of basalt, and Ewall soils along terraces. These inclusions make up about 10 percent of this map unit.

Permeability is moderately rapid. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate. The hazard of wind erosion is high.

This soil is used as nonirrigated cropland and as rangeland. The main limitation to these uses is the hazard of wind and water erosion.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and grain. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, early seeding of fall grain, and stripcropping reduce erosion and the loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop may be needed to reduce erosion. Level terraces can be used to intercept excess surface runoff. Stripcropping at right angles to the prevailing wind or seeding permanent grass can reduce wind erosion. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. Sprinkler irrigation can increase crop yield. All crops respond to fertilizer.

The potential native vegetation on the rangeland is bluebunch wheatgrass and Idaho fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This map unit is in capability subclass IIIe, nonirrigated.

55-Reardan silt loam, 0 to 7 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess and in residuum of basalt. The elevation is 1,500 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 16 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown silt loam 13 inches thick. The upper part of the subsoil is pale brown silt loam 10 inches thick, and the lower part is pale brown silty clay loam to a depth of 60 inches. In places, the slope is more than 7 percent.

Included in mapping are Tucannon soils on basalt plateaus, Cheney soils on terraces, and Dragoon soils on buttes. These included soils make up about 15 percent of this map unit.

Permeability is slow. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as nonirrigated cropland. There are few limitations to this use. In some years, tillage operations may be delayed in spring because of wetness.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and wheat. Oats and spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, and early seeding of fall grain reduce erosion and loss of soil moisture. Level terraces can be used to intercept excess surface water. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIe, nonirrigated.

56-Reardan silt loam, 7 to 25 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess and in residuum of basalt. The elevation is 1,500 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 16 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown silt loam 13 inches thick. The upper part of the subsoil is

pale brown silt loam 10 inches thick, and the lower part is pale brown silty clay loam, to a depth of 60 inches. In places, basalt is at a depth of 40 to 60 inches.

Included in mapping are Broadax soils on uplands and Dragoon soils on buttes. Also included are eroded soils that have a silty clay loam surface layer and carbonate accumulations. The included soils make up about 15 percent of this map unit.

Permeability is slow. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion. In some years, tillage operations may be delayed in spring because of wetness.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and wheat. Oats or spring wheat can be substituted for spring barley.

Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, divided-slope farming, seeding early in fall, and stripcropping reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Where concentrated runoff occurs in the drainageways, double seeding of fall grain or use of grassed waterways helps to reduce erosion. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IIIe, nonirrigated.

57-Reardan silt loam, 25 to 40 percent slopes. This is a very deep, well drained soil that generally is on north- and northwest-facing slopes of uplands. It formed in a mixture of loess and residuum of basalt. The elevation is 1,500 to 2,500 feet. The native vegetation is mainly grasses. The average annual precipitation is 16 to 18 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown silt loam 13 inches thick. The upper part of the subsoil is pale brown silt loam 10 inches thick, and the lower part is pale brown silty clay loam to a depth of 60 inches. In places, the slope is more than 40 percent, and the surface layer is less than 13 inches thick.

Included in mapping are Dragoon soils near buttes, Broadax soils on ridgetops, and soils that have a surface layer that is 5 to 10 percent gravel. These included soils make up about 15 percent of this map unit.

Permeability is slow. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

The soil is used mainly as nonirrigated cropland. The main limitations to this use are the hazard of erosion and the slope. In some years, tillage operations may be delayed in spring because of wetness.

Winter wheat, barley, alfalfa, and grass are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; winter wheat, spring barley, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and wheat. Spring wheat and oats can be substituted for spring barley. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, divided-slope farming, and seeding early in fall reduce erosion and loss of soil moisture. All crop residue. should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IVe, nonirrigated.

58-Renslow silt loam, 0 to 5 percent slopes. This is a very deep, well drained soil on broad ridgetops on uplands. It formed in loess. The elevation is 1,500 to 2,400 feet. The native vegetation is mainly grasses. The average annual precipitation is 10 to 13 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam 10 inches thick. The subsoil is brown silt loam 18 inches thick. The substratum is pale brown and light yellowish brown silt loam to a depth of 60 inches. In places, the slope is more than 5 percent.

Included in mapping are Ritzville soils on uplands, Willis and Endicott soils on south-facing slopes of the uplands, and Emdent soils in basins. Also included are soils that have lime accumulations at a depth of more than 43 inches. These included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as nonirrigated cropland. The main crop is winter wheat. Due to the low annual precipitation the cropping system consists of wheat and fallow. Stubble-mulch tillage and chiseling the stubble in fall reduce loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Level terraces can be used to intercept excess surface water. Stripcropping at right angles to the prevailing wind reduces wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IIe, nonirrigated.

59-Renslow silt loam, 5 to 25 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 1,500 to 2,400 feet. The native vegetation is mainly grasses. The average annual precipitation is 10 to 13 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 130 to 150 days.

Typically, the surface layer is grayish brown silt loam 10 inches thick. The subsoil is brown silt loam 18 inches thick. The substratum is pale brown and light yellowish brown silt loam to a depth of 60 inches. In places, the slope is more than 25 percent.

Included in mapping are soils in which the surface layer and the subsoil are mixed and Willis and Endicott soils on south-facing slopes. Also included are Anders soils on basalt plateaus, Benge soils on terraces, and soils that are underlain by basalt at a depth of 40 to 60 inches. The included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion.

The main crop is winter wheat. Due to the low annual precipitation the cropping system consists of wheat and fallow. Stubble-mulch tillage, chiseling or subsoiling the stubble in fall, cross-slope tillage, and seeding wheat early in fall reduce erosion. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Stripcropping at right angles to the prevailing wind and seeding to permanent grass reduce wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IVe, nonirrigated.

60-Ritzville silt loam, 0 to 5 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 1,300 to 2,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 120 to 160 days.

Typically, the surface layer is grayish brown silt loam 6 inches thick. The subsoil is brown silt loam 28 inches thick. The substratum is pale brown and yellowish brown silt loam to a depth of 60 inches. In places, the slope is more than 5 percent.

Included in mapping are Willis soils on south-facing slopes of the uplands, Emdent soils in basins, and Renslow soils on the uplands. Also included are soils that are underlain by basalt at a depth of 40 to 60 inches. The included soils make up about 10 percent of this unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as nonirrigated cropland. The main crop is winter wheat. Due to the low annual precipitation the cropping system consists of wheat and fallow. Stubble-mulch tillage and chiseling the stubble in fall reduce loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Level terraces can be used to intercept excess surface water. Stripcropping at right angles to the prevailing wind reduces wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IIIe, nonirrigated.

61-Ritzville silt loam, 5 to 25 percent slopes. This is a very deep, well drained soil on side slopes on uplands. It formed in loess. The elevation is 1,300 to 2,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 120 to 160 days.

Typically, the surface layer is grayish brown silt loam 6 inches thick. The subsoil is brown silt loam 28 inches thick. The substratum is pale brown and yellowish brown silt loam to a depth of 60 inches. In places, the slope is more than 25 percent.

Included in mapping are soils that have a surface layer containing soft powdery carbonate accumulations and Willis soils on south-facing slopes of the uplands. Also included are soils that have a surface layer of fine sandy loam, soils that are underlain by basalt at a depth of 40 to 60 inches, Emdent soils in basins, and Renslow soils on the uplands. The included soils make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion.

The main crop is winter wheat. Due to the low annual precipitation, the cropping system consists of wheat and fallow.

Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, and seeding early in fall reduce erosion. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Stripcropping at right angles to the

prevailing wind reduces wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation increases crop yield.

This map unit is in capability subclass IVe, nonirrigated.

62-Riverwash. This miscellaneous area consists of recently deposited alluvium that is unconsolidated and generally stratified. The alluvium varies widely in texture but commonly is sandy, very gravelly, and very cobbly. It is subject to frequent change by stream overflow and is mainly barren of vegetation.

This miscellaneous area is in capability class VIII, nonirrigated.

63-Rock outcrop. In this miscellaneous area, 90 percent of the surface is exposed bedrock. Soil material is among the outcrops. On the map, areas of Rock outcrop smaller than 2 acres are indicated by a spot symbol.

This miscellaneous area is in capability class VIII, nonirrigated.

64-Roloff silt loam, 0 to 5 percent slopes. This is a moderately deep, well drained soil on basalt plateaus. It formed in loess over basalt. The elevation is 1,300 to 1,700 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 140 to 160 days.

Typically, the surface layer is grayish brown silt loam 8 inches thick. The subsoil is brown silt loam 7 inches thick. The substratum is brown silt loam 8 inches thick. It is underlain by basalt. The depth to basalt ranges from 20 to 40 inches. In places, the surface layer is 10 to 20 percent coarse fragments.

Included in mapping are outcrops of basalt, Stratford soils on terraces, and soils that are underlain by basalt at a depth of 20 to more than 60 inches. These inclusions make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as nonirrigated cropland and as rangeland. The moderate depth to basalt, which limits the available water capacity of the soil, is a limitation to these uses.

Winter wheat is the main crop. Because of the low annual precipitation the cropping system consists of wheat and fallow. Stubble-mulch tillage and chiseling the stubble ground in fall reduce loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to control erosion. Level terraces can be used to intercept excess surface water. Including grass and alfalfa in the cropping system controls erosion, increases fertility, and maintains or improves tilth. Stripcropping at right angles to the prevailing wind reduces wind erosion. All crops respond to nitrogen fertilizer. Sprinkler irrigation can increase crop yield.

On the rangeland the potential native vegetation is bluebunch wheatgrass and Idaho fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

The use of this soil as septic tank absorption fields and as homesites is limited mainly by the moderate depth to basalt.

This map unit is in capability subclass IVe, nonirrigated.

65-Roloff-Bakeoven-Rock outcrop complex, 0 to 15 percent slopes. This complex is on basalt plateaus in the channeled scablands. The soils formed in loess over basalt. The elevation is 1,300 to 1,700 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 140 to 160 days.

Roloff silt loam, 0 to 15 percent slopes, makes up about 40 percent of this complex; Bakeoven very cobbly loam, 0 to 7 percent slopes, makes up 25 percent; and Rock outcrop makes up 20 percent.

Included in mapping are small areas of Emdent soils in basins, Roloff soils on circular mounds that are underlain by basalt at a depth of more than 40 inches, and Starbuck soils on canyon breaks and basalt plateaus in areas between the Bakeoven soil and the Roloff soil. In places, patterned ground--a 2-foot wide ring of cobbles--surrounds the mounds. These inclusions make up about 15 percent of this complex.

The Roloff soil is moderately deep and well drained. Typically, the surface layer is grayish brown silt loam 8 inches thick. The subsoil is brown silt loam 7 inches thick. The substratum is brown silt loam 8 inches thick. It is underlain by basalt. The depth to basalt ranges from 20 to 40 inches. In places, the surface layer is 10 to 20 percent coarse fragments.

Permeability of the Roloff soil is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is slow, and the hazard of erosion is slight.

The Bakeoven soil is very shallow and well drained. Typically, the surface layer is brown very cobbly loam 2 inches thick. The subsoil is brown very cobbly loam 3 inches thick. It is underlain by basalt. The basalt generally is at a depth of 4 to 10 inches. In places, it is at a depth of more than 10 inches.

Permeability of the Bakeoven soil is moderately slow. The available water capacity is very low. The effective rooting depth is 4 to 10 inches. Surface runoff is rapid, and the hazard of erosion is high.

In areas of Rock outcrop, 90 percent of the surface is exposed basalt. Most areas of Rock outcrop are nearly level and gently sloping. Some are escarpments 10 to 50 feet high. Talus is on the slopes halfway up the escarpment.

The soils in this complex are used as rangeland. The shallowness to basalt, which limits the available water capacity of the soil, is a limitation to this use. The cobbles in the surface layer and the Rock outcrop, which interfere with the use of machinery, are limitations also.

The potential native vegetation on the Roloff soil is bluebunch wheatgrass and Idaho fescue. The potential native vegetation on the Bakeoven soil is Sandberg bluegrass and stiff sagebrush. The range deteriorates if the proportion of Sandberg bluegrass, bluebunch wheatgrass, and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. The Roloff soil can be seeded with a grain drill.

The use of the soils in this complex as septic tank absorption fields and as homesites is limited mainly by the shallowness to basalt.

This complex is in capability subclass VIIs, nonirrigated.

66-Shano silt loam, 0 to 15 percent slopes. This is a very deep, well drained soil on uplands. It formed in loess. The elevation is 1,300 to 1,700 feet. The native vegetation is mainly grasses. The average annual precipitation is 6 to 9 inches,' the mean annual temperature is about 50 degrees F, and the frost-free season is 140 to 170 days.

Typically, the surface layer is pale brown silt loam 6 inches thick. The subsoil is pale brown silt loam 16 inches thick. The upper part of the substratum is pale brown silt loam 11 inches thick. The lower part of the substratum is pale brown silt loam to a depth of 60 inches. In places, the substratum has alternate layers of loess and lime-silica cemented hardpan.

Included in mapping are Willis soils on south-facing slopes and soils that are eroded and contain soft, powdery carbonate accumulations in the surface layer. Also included are soils that are underlain by basalt at a depth of 40 to 60 inches and soils that have slope of more than 15 percent. The included soils make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The main limitation to this use is the hazard of erosion. Winter wheat is the main crop. Because of the low annual precipitation, the cropping system consists of wheat and fallow. Stubble-mulch tillage, chiseling the stubble in fall, and early seeding in fall reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to control erosion. Level terraces can be used to intercept excess surface water. Stripcropping at right angles to the prevailing wind reduces wind erosion. All crops respond to fertilizer. Sprinkler irrigation can increase crop yield.

This map unit is in capability subclass IVe, nonirrigated.

67-Speigle very stony silt loam, 25 to 55 percent slopes. This is a very deep, well drained soil on north-facing canyon slopes. It formed in a mixture of colluvium that derived from basalt and loess. The elevation is 1,400 to 2,600 feet. The native vegetation is mainly conifers and grasses. The average annual precipitation is 16 to 20 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 110 to 120 days.

Typically, a thin mat of undecomposed needles, leaves, and twigs overlies the surface layer, which is grayish brown very stony silt loam 4 inches thick. The subsoil is brown very stony loam 10 inches thick. The substratum is yellowish brown and brown very cobbly loam to a depth of 60 inches. In places, basalt is at a depth of 40 to 60 inches.

Included in mapping are outcrops of granite, Speigle soils that have a silty clay loam surface layer, and soils that are less than 35 percent rock fragments. These inclusions make up about 10 percent of this map unit.

Permeability is moderate. The available water capacity is moderate. The effective rooting depth is 60 inches or more. Surface runoff is rapid, and the hazard of erosion is high.

Douglas-fir is the most common tree on this soil. The site index, based on a 100-year site curve, is 66. The culmination of the mean annual increment is 51 cubic feet per acre at 50 years. The steepness of slope and the stoniness of the surface layer, which interfere with the use of machinery, are limitations to woodland use. The hazard of erosion is a limitation also. Plant competition may hinder the regeneration of a stand.

This map unit is in capability subclass VIIs, nonirrigated.

68-Spens extremely gravelly loamy sand, 25 to 50 percent slopes. This is a very deep, somewhat excessively drained soil on terrace breaks. It formed in glacial outwash. The elevation is 1,400 to 1,800 feet. The native vegetation is mainly grasses and trees. The

average annual precipitation is 17 to 20 inches, the mean annual temperature is about 47 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is grayish brown extremely gravelly loamy sand 5 inches thick. The underlying material is brown extremely gravelly loamy sand to a depth of 60 inches or more. In places, the surface layer is stony or cobbly and has a cover of partially decomposed litter consisting of pine needles and twigs.

Included in mapping are Ewall and Springdale soils on terraces and outcrops of basalt and granite. These inclusions make up about 10 percent of this map unit.

Permeability is very rapid. The available water capacity is very low. The effective rooting depth is 60 inches or more. Surface runoff is slow to medium, and the hazard of erosion is moderate.

This soil is used as grazable woodland. The dominant native range grass is bluebunch wheatgrass. The range deteriorates if the proportion of bluebunch wheatgrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. The use of chemicals and burning can control brush. Seeding is advisable if the range has deteriorated.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 69. The culmination of the mean annual increment is 54 cubic feet at 50 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. The use of equipment is difficult because of the steepness of slope and soft footing. Erosion is a severe hazard in disturbed areas.

This map unit is in capability subclass VIIs, nonirrigated.

69-Spokane loam, 5 to 30 percent slopes. This is a moderately deep, well drained soil on foot slopes of the watersheds of the Columbia and Spokane Rivers. It formed in weathered granite and the overlying loess. The elevation is 1,800 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 18 to 24 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 100 to 130 days.

Typically, a 1-inch-thick mat of leaves, needles, and twigs covers the surface layer, which is grayish brown loam 8 inches thick. The subsoil is brown gravelly loam 9 inches thick. The substratum is pale brown gravelly sandy loam 19 inches thick. It is underlain by weathered granite. Generally, the weathered granite is at a depth of 20 to 40 inches. In places, it is at a depth of 40 to 60 inches.

Included in mapping are circular depressions high in content of volcanic ash and soils that have a surface layer that is 10 to 20 percent rock fragments. Also included are Dragoon soils on uplands near buttes and Springdale and Ewall soils on terraces. The inclusions make up about 15 percent of this map unit.

Permeability is moderately rapid. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as nonirrigated cropland and as grazable woodland. The main limitation to these uses is the moderate depth to weathered rock.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring wheat or barley, and fallow; or a combination of alfalfa and grass followed by fallow and grain. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, early seeding, stripcropping, and divided-slope farming reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. Where concentrated runoff occurs in the drainageways, double seeding of fall grain or use of grassed waterways helps to reduce erosion. The grass and alfalfa in the cropping system control erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

On the grazable woodland the dominant native range grasses are pinegrass and blue wildrye. The range deteriorates if the proportion of blue wildrye and pinegrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. The use of chemicals and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill in areas that have been cleared.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa. pine the site index, based on a 100-year site curve, is 92 but varies according to the depth of the soil to bedrock. The culmination of the mean annual increment is 88 cubic feet at 40 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a severe hazard.

This map unit is in capability subclass IVe, nonirrigated.

70-Spokane very stony loam, 5 to 30 percent slopes. This is a moderately deep, well drained soil on side slopes of foothills along canyons of the Columbia and Spokane Rivers. It formed in weathered granite and the overlying loess. The elevation is 1,800 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 18 to 24 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 100 to 130 days.

Typically, a 1-inch-thick mat of leaves, needles, and twigs covers the surface layer, which is grayish brown very stony loam 8 inches thick. The subsoil is brown gravelly loam 9 inches thick. The substratum is pale brown gravelly sandy loam 19 inches thick. It is underlain by weathered granite. The depth to weathered granite ranges from 20 to 40 inches.

Included in mapping are soils that do not have stones in the surface layer, Dragoon soils near buttes, Springdale and Ewall soils along outwash terraces, soils that have slopes of more than 30 percent, and outcrops of granite and basalt. These inclusions make up about 15 percent of this map unit.

Permeability is moderately rapid. The available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used as grazable woodland. This use is limited mainly by the large stones in the surface layer.

The dominant native range grasses are pinegrass and blue wildrye. The range deteriorates if the proportion of pinegrass and blue wildrye decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Burning and the use of chemicals can control brush. Seeding is advisable if the range has deteriorated.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa pine the site index, based on a 100-year site curve, is 92 but varies according to the depth of the soil to bedrock. The culmination of the mean annual increment is 88 cubic feet at 40 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a severe hazard.

This map unit is in capability subclass VIs, nonirrigated.

71-Spokane very stony loam, 30 to 55 percent slopes. This is a moderately deep, well drained soil on side slopes of foothills along canyons of the Columbia and Spokane Rivers. If formed in weathered granite and the overlying loess. The elevation is 1,800 to 3,000 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 18 to 24 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 100 to 130 days.

Typically, a 1-inch-thick mat of leaves, needles, and twigs covers the surface layer, which is grayish brown very stony loam 8 inches thick. The subsoil is brown gravelly loam 9 inches thick. The substratum is pale brown gravelly sandy loam 19 inches thick. It is underlain by weathered granite. The depth to weathered granite ranges from 20 to 40 inches. In places, the surface layer is less than 10 percent stones.

Included in mapping are Dragoon soils on buttes and outcrops of granite, dolomite, and basalt. These inclusions make up about 15 percent of this map unit.

Permeability is moderately rapid. The available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is high.

This soil is used as grazable woodland. The main limitations are the stones in the surface layer and the steepness of the slope. The dominant native range grasses are pinegrass and blue wildrye. The range deteriorates if the proportion of pinegrass and blue wildrye decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Burning and the use of chemicals can control brush. Seeding is advisable if the range has deteriorated.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa pine the site index, based on a 100-year site curve, generally is 92, but it varies according to the depth of the soil to bedrock. The culmination of the mean annual increment is 88 cubic feet at 40 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a severe hazard.

This map unit is in capability subclass VIIs, nonirrigated.

72-Spokane-Rock outcrop complex, very steep. This complex is on canyon slopes of foothills that drain into the Columbia and Spokane Rivers. The elevation is 1,800 to 3,000 feet. The slope is 30 to 55 percent. The native vegetation is mainly grasses and conifers. The average annual precipitation is. 18 to 24 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 100 to 130 days.

Spokane loam, 30 to 55 percent slopes, makes up about 40 percent of this complex, and Rock outcrop makes up about 25 percent. Included soils make up the rest.

Included in mapping are areas of Spokane very stony loam, Springdale and Ewall soils on outwash terraces, and soils that are underlain by granite at a depth of 10 to 20 inches.

The Spokane soil is moderately deep and well drained. It formed in weathered granite and the overlying loess. Typically, a 1-inch-thick mat of leaves, needles, and twigs covers the surface layer, which is grayish brown loam 8 inches thick. The subsoil is brown gravelly loam 9 inches thick. The substratum is pale brown gravelly sandy loam 19 inches thick. It is underlain by weathered granite. The weathered granite generally is at a depth of 20 to 40 inches. In places, it is at a depth of more than Winches.

Permeability is moderately rapid. The available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Surface runoff is rapid, and the hazard of erosion is high.

In areas of Rock outcrop, 90 percent of the surface is exposed bedrock.

The Spokane soil is used as grazable woodland. The main limitations are stones on the surface, Rock outcrop, and steepness of slope. The dominant native range grasses are bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated.

Ponderosa pine is the most common tree on this soil. Douglas-fir is scattered in some areas. For ponderosa pine the site index, based on a 100-year site curve, is 92 but varies according to the depth of the soil to bedrock. The culmination of the mean annual increment is 88 cubic feet at 40 years. The stands vary in density; however, they commonly are open. Productivity, therefore, is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a severe hazard.

This map unit is in capability subclass VIIs, nonirrigated.

73-Springdale gravelly sandy loam, 0 to 7 percent slopes. This is a very deep, somewhat excessively drained soil on terraces along the Columbia and Spokane Rivers. It formed in glacial outwash. The elevation is 1,400 to 1,800 feet. The native vegetation is mainly grasses and conifers. The average annual precipitation is 17 to 20 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is grayish brown and brown gravelly sandy loam 9 inches thick. The upper part of the underlying material is pale brown very gravelly loamy coarse sand 15 inches thick. The lower part of the underlying material is multicolored very gravelly sand to a depth of 60 inches. In places, the surface layer is 10 percent cobbles, is less than 15 percent gravel, and has a cover of partially decomposed litter consisting of pine needles, leaves, and twigs.

Included in mapping are small, circular depressions that are high in content of volcanic ash. Also included are soils that have stones in the surface layer and Ewall soils on terraces. The inclusions make up about 10 percent of this map unit.

Permeability is moderately rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used mainly as grazable woodland. In a few small areas it is used as irrigated and nonirrigated cropland. The main limitations of this soil for these uses are low natural fertility and low available water capacity.

The dominant native vegetation is needleandthread and bluebunch wheatgrass. The range deteriorates if the proportion of needleandthread and bluebunch wheatgrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Seeding is advisable if the range has deteriorated. A permanent vegetative cover helps protect this soil from erosion by wind and water.

Ponderosa pine is the most common tree on this soil. The site index, based on a 100-year site curve, is 69. The culmination of the mean annual increment is 54 cubic feet per acre at 50 years. The high soil temperature during summer at exposed sites is the main cause of seedling mortality. In areas that have a heavy understory of cheatgrass, fire is a severe hazard.

Grass and alfalfa pastures are grown on this soil with sprinkler irrigation. Wheat and barley can be grown during reestablishment of alfalfa and grass for hay and pasture. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IVs, nonirrigated.

74-Springdale cobbly sandy loam, 0 to 15 percent slopes. This is a very deep, somewhat excessively drained soil on terraces along the Columbia and Spokane Rivers. It formed in glacial outwash. The elevation is 1,400 to 1,800 feet. The average annual precipitation is 17 to 20 inches, the mean annual temperature is about 46 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is grayish brown and brown cobbly sandy loam 9 inches thick. The upper part of the underlying material is pale brown very gravelly loamy coarse sand 15 inches thick. The lower part of the underlying material is multicolored very gravelly sand to a depth of 60 inches. In places, a partially decomposed litter of pine needles, leaves, and twigs covers the surface layer.

Included in mapping are soils that have a gravelly surface layer, outcrops of granite along the steeper slopes, and Spens soils on terrace breaks. These inclusions make up about 10 percent of this map unit.

Permeability is moderately rapid. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is slow, and the hazard of erosion is moderate.

This soil is used mainly as woodland. The main limitations to this use are the low natural fertility of the soil and the cobbles in the surface layer. The cobbles interfere with the operation of machinery.

Ponderosa pine is the most common tree on this soil. Based on a 100-year site curve, the site index is 69 for

ponderosa pine. Yield tables indicate the mean annual increment at culmination is 54 cubic feet per acre at 50 years. The stands vary in density. In open stands the productivity is less than the potential indicated by the site index. The high soil temperature during summer is the main cause of seedling mortality.

This map unit is in capability subclass VIIs, nonirrigated.

75-Starbuck cobbly silt loam, 0 to 20 percent slopes. This is a shallow, well drained soil on basalt plateaus along major drainageways. It formed in loess over basalt. The elevation is 1,400 to 2,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 8 to 12 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 140 to 180 days.

Typically, the surface layer is brown cobbly silt loam 9 inches thick. The subsoil is yellowish brown silt loam 6 inches thick. It is underlain by basalt. The depth to basalt ranges from 12 to 20 inches. In places, the surface layer is stony.

Included in mapping are colluvial slopes with basalt at a depth of more than 20 inches, hummocky, nearly level soils more than 20 inches deep to basalt, small circular areas high in content of volcanic ash, and soils that do not have cobbles in the surface layer. These inclusions make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is very low. The effective rooting depth is 12 to 20 inches. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as rangeland. The shallowness to basalt, which limits the available water capacity of the soil, and the cobbles in the surface layer, which interfere with the operation of machinery, are limitations to this use.

The potential native vegetation is bluebunch wheatgrass and Sandberg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Sandberg bluegrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Brush can be controlled by the use of chemicals and by burning. Seeding is advisable if the range has deteriorated.

This map unit is in capability subclass VIe, nonirrigated.

76-Strat very cobbly silt loam, 3 to 25 percent slopes. This is a very deep, well drained soil on outwash plains and terrace escarpments. It formed in glacial outwash that is mixed with loess in the upper part. The elevation is 1,300 to 1,700 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 120 to 150 days.

Typically, the surface layer is brown very cobbly silt loam 9 inches thick. The subsoil is brown very gravelly loam 13 inches thick. The substratum is multicolored extremely gravelly coarse sand to a depth of 60 inches. In places, the surface layer is cobbly or gravelly.

Included in mapping are Stratford soils on smooth, nearly level terraces and Anders soils on outwash plateaus. These included soils make up about 10 percent of this map unit.

Permeability is moderate to a depth of 22 inches and very rapid below that depth. The available water capacity is low. The effective rooting depth is 60 inches or more. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as rangeland. The coarse-textured substratum, which limits the available water capacity of the soil, and the cobbles in the surface layer, which hinder the operation of machinery, are limitations to this use.

The potential native vegetation is bluebunch wheatgrass and Sandburg bluegrass. The range deteriorates if the proportion of bluebunch wheatgrass and Sandburg bluegrass decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Brush can be controlled by the use of chemicals and by burning. Seeding is advisable if the range has deteriorated.

The use of this soil as a site for shallow excavations is severely limited by the hazard of cutbanks caving. This soil is suited to use as homesites. The main limitations to this use are slope and large stones. If this soil is used as septic tank absorption fields, ground water pollution is a hazard because of the very rapid permeability of the substratum.

This map unit is in capability subclass VIIs, nonirrigated.

77-Stratford gravelly silt loam, 0 to 15 percent slopes. This is a very deep, well drained soil on outwash plains and terraces. It formed in glacial outwash that is mixed with loess in the upper part. The elevation is 1,300 to 1,700 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 135 to 150 days.

Typically, the surface layer is grayish brown and brown gravelly silt loam 8 inches thick. The subsoil is yellowish brown gravelly silt loam 5 inches thick. The upper part of the substratum is yellowish brown gravelly loam 11 inches thick. The lower part of the substratum is extremely gravelly coarse sand to a depth of 60 inches. In places, the surface layer is silt loam.

Included in mapping are Strat soils on side slopes of terraces and Roloff soils on outwash plateaus. Also included, in areas near basalt plateaus, are soils that have a stony or cobbly surface layer. The included soils make up about 15 percent of this map unit.

Permeability is moderate to a depth of 24 inches and very rapid below that depth. The effective rooting depth is 60 inches or more. The available water capacity is low. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland and as rangeland. The coarse-textured lower part of the substratum limits the available water capacity of the soil.

Winter wheat is the principal crop. Due to the low annual precipitation, a cropping system consisting of wheat and fallow is used. Stubble-mulch tillage and chiseling the stubble in fall conserve soil moisture. Including grass and alfalfa in the cropping system reduces erosion, increases fertility, and maintains or improves tilth. All crop residue should be returned to the soil; and enough residue to reduce erosion should be left on the surface after fall seeding. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Sprinkler irrigation can increase crop yield. The crops respond to nitrogen fertilizer.

This soil is suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass and Idaho fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This soil is well suited to use as homesites. If it is used as septic tank absorption fields, ground water pollution is a hazard because of the very rapid permeability of the substratum.

This map unit is in capability subclass IVe, nonirrigated.

78-Tucannon silt loam, 0 to 5 percent slopes. This is a moderately deep, well drained soil on basalt plateaus. It formed in loess and residuum of basalt. The elevation is 1,900 to 2,300 feet. The native vegetation is mainly grasses. The average annual precipitation is 16 to 18 inches, the mean annual temperature is about 50 degrees F, and the frost-free season is 110 to 130 days.

Typically, the surface layer is dark grayish brown silt loam 10 inches thick. The subsoil is grayish brown and brown silt loam 20 inches thick. It is underlain by basalt. The basalt generally is at a depth of 20 to 40 inches. In places, it is at a depth of more than 40 inches.

Included in mapping are Kuhl soils along major drainageways, outcrops of basalt, soils that have a gravelly surface layer, and somewhat poorly drained Emdent soils and poorly drained Cocolalla soils in basins. Also included are Cheney and Hesseltine soils on outwash terraces. The inclusions make up about 15 percent of this map unit.

Permeability is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is slow, and the hazard of erosion is slight.

This soil is used as nonirrigated cropland and as rangeland. The moderate depth to basalt, which limits the available water capacity of the soil, is a limitation to these uses. The hazard of erosion is a limitation also.

Winter wheat, barley, grass, and alfalfa are the principal crops. The crops are commonly grown in a cropping system consisting of winter wheat and fallow; winter wheat, spring barley, and fallow; or a combination of alfalfa and grass followed by fallow and grain. Spring wheat can be substituted for spring barley. Stubble-mulch tillage, chiseling the stubble in fall, cross-slope tillage, and early seeding of fall grain and stripcropping reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough residue should be left on the surface after fall plowing to reduce erosion. Where concentrated runoff occurs in the drainageways, double seeding of fall grain or use of grassed waterways helps to reduce erosion. The grass and alfalfa in the cropping system reduce erosion, increase fertility, and maintain or improve tilth. The crops respond to nitrogen fertilizer.

This soil is well suited to use as rangeland. The potential native vegetation is bluebunch wheatgrass and Idaho fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of range management. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

The use of this soil as septic tank absorption fields and as homesites is limited mainly by the moderate depth to basalt.

This map unit is in capability subclass IIIe, nonirrigated.

79-Tucannon-Rock outcrop complex, 0 to 15 percent slopes. This complex is on basalt plateaus. The elevation is 1,900 to 2,300 feet. The native vegetation is mainly grasses. The average annual precipitation is 16 to 18 inches, the mean annual temperature is about 50 degrees F, and the average frost-free season is 110 to 130 days.

Tucannon silt loam, 0 to 15 percent slopes, makes up about 50 percent of this complex, and Rock outcrop makes up 30 percent. Inclusions make up the rest.

Included in mapping are somewhat poorly drained Emdent soils, poorly drained Cocolalla soils in basins, Hesseltine soils on outwash terraces, Kuhl soils on breaks of steep slopes, and soils that have a surface layer containing stones and cobbles. Also included is patterned ground, which consists of rings of cobbles 1 to 2 feet wide and 18 to 24 inches deep. These rings surround mounds of Tucannon soil and a soil that is more than 40 inches deep to basalt.- These mounds are 10 to 60 feet in diameter.

The Tucannon soil is moderately deep and well drained. It formed in loess and residuum of basalt. Typically, the surface layer is dark grayish brown silt loam 10 inches thick. The subsoil is grayish brown and brown silt loam 20 inches thick. It is underlain by basalt. The depth to basalt ranges from 20 to 40 inches.

Permeability of the Tucannon soil is moderate. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Surface runoff is slow, and the hazard of erosion is slight.

In areas of Rock outcrop, 90 percent of the surface is exposed basalt. Most areas of the Rock outcrop are nearly level and gently sloping. Some are vertical escarpments 10 to 50 feet high. Among the outcrops are soils that are less than 10 inches deep to basalt. These soils support stiff sagebrush and Sandberg bluegrass.

The Tucannon soil is used as rangeland. The moderate depth to basalt, which limits the available water capacity of the soil, is a limitation to this use. Rock outcrop, which hinders the use of machinery, is a limitation also. The potential native vegetation is bluebunch wheatgrass and Idaho fescue. Ponderosa pine is scattered in some areas. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper grazing use and deferred-rotation grazing are the most effective and the least expensive methods of improving the range. Brush can be controlled by the use of chemicals and by burning. The Tucannon soil can be seeded with a grain drill if the range has deteriorated.

The use of the Tucannon soil as septic tank absorption fields and as homesites is limited mainly by the moderate depth to basalt and by the Rock outcrop.

This complex is in capability subclass VIe, nonirrigated.

80-Willis silt loam, 5 to 25 percent slopes. This is a moderately deep, well drained soil on uplands. It formed in calcareous loess. The elevation is 1,400 to 2,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 125 to 160 days.

Typically, the surface layer is grayish brown silt loam 9 inches thick. The subsoil is brown silt loam 10 inches thick. The substratum is pale brown silt loam in the upper 11 inches. Below that, it is a light brownish gray lime-silica cemented hardpan. The depth to the hardpan ranges from 20 to 40 inches. In places, the surface layer is calcareous.

Included in mapping are Ritzville soils on uplands and Roloff soils on basalt plateaus. Also included are soils that have a calcareous surface layer. These included soils make up about 15 percent of this map unit.

Permeability is moderate above the hardpan and very slow in the hardpan. The effective rooting depth is 20 to 40 inches. The available water capacity is low. Surface runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as nonirrigated cropland. The moderate depth to the hardpan, which limits the available water capacity of the soil, is a limitation to this use. The hazard of erosion is a limitation also. Winter wheat is the principal crop. Due to the low annual precipitation, the cropping system consists of wheat and fallow. Stubble-mulch tillage, chiseling the stubble in fall, and cross-slope tillage reduce erosion and loss of soil moisture. All crop residue should be returned to the soil; and enough surface residue to reduce erosion should be left on the surface after fall plowing. If little or no residue remains after harvest, a winter cover crop can be used to reduce erosion. Stripcropping at right angles to the prevailing wind reduces wind erosion. Sprinkler irrigation can increase crop yield. The crops respond to nitrogen fertilizer.

This map unit is in capability subclass IVe, nonirrigated.

81-Willis Variant silt loam, 5 to 25 percent slopes. This is a shallow, well drained soil on uplands. It formed in calcareous loess. The elevation is 1,400 to 2,000 feet. The native vegetation is mainly grasses. The average annual precipitation is 9 to 12 inches, the mean annual temperature is about 49 degrees F, and the frost-free season is 125 to 160 days.

Typically, the surface layer is grayish brown silt loam 12 inches thick. The next layer is a lime-silica cemented hardpan about 3 inches thick. Below that layer, to a depth of 60 inches, there is a layer of pale brown silt loam. In places, the surface layer is noncalcareous.

Included in mapping are Ritzville soils and Willis soils. The included soils make up about 15 percent of this map unit.

Permeability is moderate to the hardpan and very slow in the hardpan. The available water capacity is very low. Surface runoff is rapid, and the hazard of erosion is high. This soil is severely eroded.

This soil is used mainly as nonirrigated cropland. The shallowness to hardpan, which limits the available water capacity of the soil, is a limitation to this use. The low content of organic matter and the hazard of erosion are limitations also.

Winter wheat is the principal crop. Due to the low annual precipitation, the cropping system consists of wheat and fallow. Seeding to permanent perennial grasses is the optimum measure for erosion control. The grasses can increase fertility and improve tilth. Stubble mulch tillage, chiseling the stubble in fall, and cross-slope tillage reduce erosion. The crops respond to nitrogen fertilizer.

This soil is also used as rangeland. The potential native vegetation is bluebunch wheatgrass and Idaho fescue. The range deteriorates if the proportion of bluebunch wheatgrass and Idaho fescue decreases and the proportion of less desirable plants increases. Proper

grazing use and deferred-rotation grazing are the most effective and the least expensive methods of range management. Railing, chaining, beating, the use of chemicals, and burning can control brush. Seeding is advisable if the range has deteriorated. This soil can be seeded with a grain drill.

This map unit is in capability subclass VIe, nonirrigated.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 708,000 acres is used for winter wheat, the major crop. Of this, about 341,000 acres is in summer fallow in alternate years so that the soil can collect additional moisture for the next year of production. On about 15 percent of the summer fallow acreage the soils are sprinkler irrigated with water from deep wells to grow barley, peas, beans, alfalfa, and grass in rotation with winter wheat. The amount of acreage used for the production of winter wheat has remained the same; however, the Shano, Ritzville, and Renslow soils could be sprinkler irrigated to increase the production of wheat. Peas, beans, oats, potatoes, alfalfa, and grass for hay and pasture are well suited to sprinkler irrigation.

Most of the soils respond to a fertilizer program of nitrogen, phosphorus, potassium, and sulphur. Nitrogen is the single most important element. The use of fertilizer should be based on the results of soil tests. The Cooperative Extension Service can help determine the kind and amount of fertilizer to use on a specific crop.

Organic matter is an important source of nitrogen for crops. It also helps increase the water intake rate, helps reduce surface runoff, and promotes good soil tilth.

The Bagdad, Broadax, Hanning, Reardan, Renslow, Ritzville, and Shano soils, which are the major soils for production of wheat, have a silt loam surface layer that is subject to rill erosion. The loss of an inch of topsoil reduces wheat production about 2.5 bushels per acre (5). Soil loss in the Palouse Region over a 90-year period is estimated to be 1.7 inches on slopes of 3 to 7 percent, 6 inches on slopes of 7 to 25 percent, and 14 inches on slopes of 25 to 40 percent. Taking into account technological advances and genetic improvements, which have increased the production of wheat an average of 21.2 bushels per acre over a 40-year period (or 0.53 bushel per acre per year), the net change in production over the 40-year period on the same slope breaks would be: (1) an increase of 17.2 bushels per acre on slopes of 3 to 7 percent, (2) an increase of 7.2 bushels per acre on slopes of 7 to 25 percent and (3) a decrease of 10.8 bushels per acre on slopes of 25 to 40 percent.

This illustrates the importance of reducing the amount of erosion to a minimum and maintaining or improving the tilth of the soil. In the Palouse Region the formation

of one inch of topsoil takes an estimated 100 to 300 years.

Soil erosion results in the pollution of streams by sediments, fertilizers, and insecticides. Many dollars are required to finance the removal of sediment from county, state, and federal highways each year.

Erosion control practices provide protective surface cover, reduce runoff, and increase the infiltration rate of water. The use of a cover crop or a cover of plant residue over winter reduces surface runoff, increases water intake, and improves production. Including grass and legumes in the rotation reduces erosion, increases fertility, and maintains or improves tilth. Level terraces can intercept excess surface water (fig. 5). Chiseling and leaving the surface rough and cloddy, divided-slope farming, stripcropping, and cross-slope farming reduce surface runoff also. Subsoiling to break the tillage layer increases the infiltration rate of water in the profile. Where concentrated runoff occurs in the drainageways, double seeding of winter wheat in fall or use of grassed waterways helps to reduce gully erosion on Esquatzel, Mondovi, and Onyx soils. The coarse-textured Ewall soils need a vegetative cover to reduce wind erosion if the native grasses have been removed. Stripcropping at right angles to the prevailing wind or seeding permanent grass can reduce wind erosion. Reducing the speed of the tractor when farming reduces gravitational soil movement down the slope. Minimum tillage reduces the

Figure 5.-In this area of Bagdad silt loam, 0 to 7 percent slopes, terraces are used to reduce the length of the slope and thus reduce rill erosion.

breakdown of soil structure. The surface layer of structureless soil is subject to puddling and crusting alter rain.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general *way,* the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects.: Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII: The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Lawrence P. Lilly, area range conservationist, Soil Conservation Service, assisted in writing this section.

Lincoln County rangeland makes up 10 percent of the rangeland in Washington. About 464,000 acres in Lincoln

County is rangeland. This rangeland produces about 3 percent of the beef cattle raised in Washington.

Most of the rangeland is in the channeled scablands, which extends throughout Lincoln County in a northeast-southwest pattern. The soils in the scablands are shallower than the cultivated soils on the adjacent uplands. The scablands are the result of intensive scouring by glacial meltwater, and they contain shallow soils underlain by basalt or glacial outwash gravel, cobbles, and sand. Also included in the scablands are depressions and potholes containing wet meadows and alkaline soils.

In the scablands, the density and composition of the forage vary according to the average annual precipitation, which ranges from 8 inches in the southwest to 18 inches in the northeast. The drier southwestern part of the county supports a sparse potential natural plant community of wheatgrasses, primarily bluebunch wheatgrass, and forbs and a few perennial shrubs, primarily big sagebrush and rubber rabbitbrush. There is a transition zone where bluebunch wheatgrass and Idaho fescue are associated with big sagebrush. Idaho fescue occurs on the north-facing slopes and bluebunch wheatgrass on the south-facing slopes. Further eastward the potential natural plant community includes a wide variety of highly productive forage grasses. Threetip sagebrush is dominant over big sagebrush and is associated with Idaho fescue. Bluebunch wheatgrass is better represented on the drier sites. Ponderosa pine occurs on some northern aspects, where the effective moisture can support such vegetation.

Some rangeland is on glacial outwash terraces and in the sparsely timbered canyons that break into Lake Roosevelt in the northern part of the county. The soils in these areas consist of loam or sandy loam that is underlain by granite bedrock, or outwash gravel, cobbles, and sand at a depth of less than 40 inches.

The timbered soils support ponderosa pine, which is associated with Idaho fescue. Fairly dense patches of bitterbrush are distributed in these ponderosa pine-Idaho fescue zones. Forage grasses are sparse because much of the available moisture is consumed by woody plants. The timbered soils are not as productive as the scabland soils.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 7 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation-the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil-is listed by common name. Under *composition,* the expected percentage of total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to keep the plants growing on a site about the same in kind and amount as the potential natural plant community for that site.

Such management generally results in the optimum production of vegetation, reduction of undesirable species, conservation of water, and control of wind and water erosion of soil. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

woodland management and productivity

Robert J. Olson, woodland specialist, Soil Conservation Service, assisted in writing this section.

The soils that support woodland in Lincoln County take in an area of about 70,000 acres in the northeastern corner of the county. They are basalt plateaus, the steep north-facing breaks along the Columbia and Spokane Rivers, and the wide sandy terraces above these rivers.

Only ponderosa pine grows on the plateaus and sandy terraces. It may have an understory of bluebunch wheatgrass or snowberry. On the sandy terraces it may have an understory of bitterbrush, bluebunch wheatgrass, or needlegrass. Douglas-fir dominates the steep north-facing slopes. It has an understory of ninebark, snowberry, and pinegrass.

The woodland soils can support only stands of relatively low density. Therefore, intensive management of these soils for timber production alone commonly is not practiced. Intensive management is practical for multiple uses of timber production, grazing, wildlife habitat, and recreation.

Whitetail and mule deer are hunted. Ruffed grouse are present in the steep north slope canyons and sharp-tailed grouse are in the transition area between the woodlands and the prairie soils.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol,* a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table *8, slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate,* that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as *a site index.* This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. The site index for ponderosa pine and Douglas-fir and the culmination of mean annual increment listed in the map unit descriptions were based on the USDA-Forest Service Technical Bulletin No. 630 (7). Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Robert Olson, woodland conservationist, Soil Conservation Service, assisted in writing this section.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

In many areas of Lincoln County there are few trees and shrubs; however, windbreaks can be established if properly managed.

The most effective arrangement of windbreak plantings consists of dense, low-growing shrubs in the windward rows, taller deciduous trees or shrubs in the center row or rows, and evergreen trees or shrubs in the leeward rows: Such an arrangement makes the windbreak more effective in winter. Also, it makes the evergreens visible from the farmstead. If only one or two rows are to be planted, species that give maximum protection should be selected. If protection for a large area is needed, tall trees should be planted. If the planting is to control ground winds for a short distance, dense shrubs or evergreens are most effective. Generally, there will be an effective reduction of wind movement on the leeward side of the planting to a distance equal to 10 to 20 times the height of the windbreak.

Plantings suitable for windbreaks have been tested at the State Agricultural Experiment Stations at Lind and Prosser. Caragana is the shrub most commonly used in the windward row. Green ash and black locust are the most suitable deciduous trees for dryland areas. These species, and Lombardy poplar as well, are commonly grown under irrigation. Rocky Mountain juniper, Austrian pine, and Norway spruce are the most commonly used evergreens.

The spacing between rows and between the trees and shrubs in the rows is most important. In dryland plantings the rows should be 20 to 24 feet apart. In irrigated plantings the rows should be 16 feet apart. In the rows, the trees should be 6 to 12 feet apart, and the shrubs should be 2 to 3 feet apart.

Other aspects of layout are important also. The plantings should be at least 100 feet from the farmstead so that there will be some air movement on hot days. Rows should be spaced so that they can be worked with available equipment. Rounded corners are easier to cultivate than square ones. In an irrigated area it is necessary to consider the irrigation system and the hazard of damage to underground pipes. It is necessary also to consider the hazard of damage to overhead powerlines.

The areas should be free of vegetation before trees are planted.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

The northern boundary of Lincoln County includes about 70 miles of the shoreline of Roosevelt Lake in the Coulee Dam Recreation Area. Roosevelt Lake is the backwater of Grand Coulee Dam on the Columbia and Spokane Rivers. The National Park Service maintains nine campgrounds in this area, all accessible by boat. Five of these campgrounds have boat launching facilities. Swimming, water skiing, boating, sailing, picnicking and fishing are all popular recreation in the area. The shoreline, uncongested and surrounded by vast recreation facilities, has potential use as a site for vacation homes.

In the channeled scablands there are about 50 lakes, ranging in size from the Sprague Lake to less than two acres. These lakes are suitable for fishing, boating, and swimming, and they provide blinds for hunting migatory waterfowl. For the photographer and others the wildflowers on the basalt plateaus provide an array of vivid colors in early May. Upland birds are common for the scattergun hunter.

The steep canyon slopes along the major rivers provide isolated, scenic areas for the backpacker, hiker, horseback rider, and hunter.

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the

ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Ivan L. Lines, Jr., general biologist, Soil Conservation Service, assisted in writing this section.

Prior to the late 1800's, the landscape in Lincoln County was rangeland dominated by relatively and grass- shrub plant communities. With the advent of cultivation, much of the rangeland in general soil map units 1, 2, 3, and 4 was converted to cropland. This conversion has reduced the amount of habitat available for native rangeland wildlife such as sage grouse and sharp-tailed grouse.

Crop production, on the other hand, improves the food source for waterfowl as well as introduced game birds.

Canada geese and mallards in particular feed on waste grain in cultivated fields during fall migrations. The edge between native vegetation and cultivated land provides habitat for the introduced species including the ring-necked pheasant, chukar and gray partridge, California quail, and, to a lesser extent, wild turkey.

The coyote is a common predator in mixed rangeland-cropland areas, feeding on jackrabbits and squirrels. Jackrabbit populations are cyclic while ground squirrels are generally abundant, even to the extent of causing crop damage in some areas.

In general, the amount and quality of habitat for small birds and mammals have declined over the years. Practices such as intense cultivation, burning, spraying, and overgrazing limit wildlife numbers. In most areas improvement of the wildlife habitat can be a secondary benefit of soil conserving practices.

As a result of glacial activity, numerous potholes, lakes, wet meadows, and drainageways are interspersed in the rangeland in general soil map units 5, 6, and 7. Many of these areas contain aquatic plant communities, semi-aquatic herbaceous vegetation, or woody riparian plants. The basins and potholes provide good nesting :areas for Canada geese and ducks. Shore birds, muskrats, and occasionally an otter or beaver also inhabit the wetlands and riparian areas. Woody riparian zones provide valuable winter food and cover for upland birds and mammals, particularly sharp-tailed grouse.

Zones of higher precipitation support scattered stands of ponderosa pine. Douglas-fir occurs on some of the more moist north-facing slopes. The wooded areas are inhabited by deer, porcupines, and turkeys. Rock outcrops and talus slopes in these areas are the preferred habitat for marmots and rattlesnakes.

Bushy draws and timbered areas in general soil map units 8 and 9 provide good food and cover for mule, white-tailed deer, and ruffed grouse. Turkeys have been introduced recently and have adapted fairly well to the scattered timber areas. California quail and ringnecked

pheasant utilize the cover in bushy draws. Gray and chukar partridge utilize the more open grassy slopes along the Spokane and Columbia Rivers.

The most notable fish habitat in the county is Lake Roosevelt. This lake, and the smaller lakes in the county, provide good fishing for trout, walleye, largemouth bass, perch, and sunfish. Many of the small farm ponds are stocked with gamefish, commonly trout or largemouth bass.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are wheat and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bluebunch wheatgrass, Idaho fescue, pinegrass, Thurber needlegrass, Sandberg bluegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are balsamroot, lupine, buckwheat, cheatgrass, yarrow, and tall wheatgrass.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are ponderosa pine, aspen, and fir.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are bitterbrush, snowberry, rabbitbrush, wildrose, hawthorn, and big sagebrush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattail, wild millet, saltgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include California quail, pheasant, meadowlark, field sparrow, cottontail, and coyote.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife

attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include mule deer, sharp-tailed grouse, sage grouse, meadowlark, jackrabbit and red-tailed hawk.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than *6* feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 13 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils.

Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less

than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for-each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material -in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds, that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a

cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SPSM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent. *Very high,* greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or Water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind

erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 17, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Tables 18 and 19 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on

the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. Only saturated zones within a depth of about 6 feet are indicated. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table--that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Depth to bedrock is given in table 19, if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (8). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 20, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in sol An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Xerolls *(Xer,* meaning dry, plus *oll* from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploxerolls *(Hapl,* meaning minimal horizonation, plus *xeroll,* the suborder of the Mollisols that have a xeric moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haploxerolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed, mesic Typic Haploxerolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (6). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (8). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Anders series

The Anders series consists of moderately deep, well drained soils that formed in loess over basalt. These soils are on basalt plateaus. The elevation is 1,600 to 2,500 feet. The slope is 0 to 15 percent. The average annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Anders silt loam, 0 to 5 percent slopes, 1,540 feet west and 2,080 feet south of the northeast corner of sec. 13, T. 26 N., R. 35 E.

Ap-0 to 3 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; neutral; clear smooth boundary.

A12-3 to 12 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few fine pores;, neutral; abrupt smooth boundary.

B21-12 to 17 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine pores; neutral; clear smooth boundary.

B22-17 to 28 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine pores; neutral; abrupt wavy boundary.

IIR-28 inches; basalt.

The basalt is at a depth of 20 to 40 inches. The mollic epipedon is 9 to 16 inches thick.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is 0 to 25 percent angular, coarse basalt fragments.

The B horizon has value of 5 or 6, dry, and 3 or 4, moist; chroma of 3 or 4, dry or moist; and hue of 10YR or 7.5YR. It is gravelly silt loam or silt loam. It has weak or moderate subangular blocky or prismatic structure.

Carbonates accumulate in fractures in the basalt.

Badge series

The Badge series consists of very deep, well drained soils. These soils are on steep canyon slopes formed in a mixture of colluvium that derived from basalt and loess. The elevation is 1,500 to 2,600 feet. The slope is 25 to 55 percent. The average annual precipitation is 12 to 15 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Badge very cobbly silt loam, 25 to 55 percent slopes, from an area of Badge-Bakeoven-Rock outcrop complex, very steep, 2,960 feet east and 700 feet north of the southwest corner of sec. 31, T. 28 N., R. 33 E.

A11-0 to 4 inches; dark grayish brown (10YR 4/2) very cobbly silt loam, very dark brown (10YR 2/2) moist; moderate fine and very fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; many roots; many very fine pores; 20 percent angular basalt pebbles, 30 percent cobbles, and 1 percent stones; mildly alkaline; abrupt wavy boundary.

A12-4 to 18 inches; dark brown (10YR 4/3) very cobbly silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common roots; common very fine and many medium pores; 35 percent angular basalt pebbles, 15 percent cobbles, and 1 percent stones; mildly alkaline; clear smooth boundary.

B21t-18 to 27 inches; brown (10YR 5/3) extremely gravelly silt loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and slightly plastic; few roots; many very fine pores; 80 percent angular basalt pebbles and 1 percent stones; very few thin clay films on faces of peds; mildly alkaline; clear smooth boundary.

B22t-27 to 34 inches; brown (10YR 5/3) extremely gravelly loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few roots; many very fine pores; 75 percent angular basalt pebbles, 5 percent cobbles; mildly alkaline; clear smooth boundary.

C-34 to 60 inches; brown (10YR 5/3) extremely gravelly loam, dark grayish brown (10YR 4/2) moist; massive; loose, slightly sticky and nonplastic; few roots; many very fine pores; 80 percent angular basalt pebbles, less than 5 percent cobbles; moderately alkaline.

These soils are usually moist but are dry between depths of 4 and 12 inches for 70 to 90 consecutive days in summer and early autumn. Reaction is neutral to moderately alkaline.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist.

The B horizon has value of 4 or 5, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist. It is silt loam, loam, or silty clay loam and 60 to 90 percent angular, coarse basalt fragments.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist. It is loam or silt loam and 60 to 90 percent angular, coarse basalt fragments. In some pedons, lime accumulates on the underside of cobbles and pebbles.

Bagdad series

The Bagdad series consists of very deep, well drained soils. The soils formed in loess on uplands. The elevation is 2,000 to 2,800 feet; The slope is 0 to 40 percent. The average annual precipitation is 12 to 15 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Bagdad silt loam, 0 to 7 percent slopes, 235 feet west and 1,155 feet south of the northeast corner of sec. 21, T. 27 N., R. 34 E.

Ap-0 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many very fine pores; slightly acid; abrupt smooth boundary.

A3-10 to 14 inches; brown (10YR 5/3) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium

granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots, many very fine pores; neutral; clear wavy boundary.

B21t-14 to 22 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak medium prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many fine pores; thin continuous siliceous coatings on vertical faces of peds; mildly alkaline; clear wavy boundary.

B22t-22 to 37 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure; hard, friable, sticky and plastic; common roots; many fine pores; thin patchy clay films on vertical faces of peds; thin continuous siliceous coatings on peds; mildly alkaline; clear wavy boundary.

C1ca-37 to 53 inches; yellowish brown (10YR 5/4) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many fine pores; strongly effervescent; carbonate material is segregated in pores and root channels; strongly alkaline; clear wavy boundary.

C2ca-53 to 60 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive, slightly hard, very friable, slightly sticky and slightly plastic; few roots; many fine pores; slightly effervescent; carbonate material occurs in a few pores; moderately alkaline.

The mollic epipedon is 10 to 20 inches thick. The thickness of the solum and the depth to secondary lime are typically 30 to 43 inches but in eroded areas are as little as 24 inches. The soils are usually moist but are dry in all parts between depths of 4 and 12 inches for 70 to 90 consecutive days following the summer solstice.

In the B horizon, reaction ranges from neutral to mildly alkaline.

The Cca horizon has value of 5 through 7, dry, and 4 or 5, moist, and chroma of 3 or 4, dry or moist.

Bakeoven series

The Bakeoven series consists of very shallow, well drained soils. These soils formed in loess over basalt on plateaus. The elevation is 1,700 to 2,600 feet. The slope is 0 to 7 percent. The average annual precipitation is 10 to 16 inches, and the mean annual temperature is about 52 degrees F.

Typical pedon of Bakeoven very cobbly loam, 0 to 7 percent slopes, 1,800 feet south and 400 feet west of the northeast corner of sec. 22, T. 25 N., R. 36 E.

A1-0 to 2 inches; brown (10YR 5/3) very cobbly loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; slightly hard, very friable, nonsticky and nonplastic; common roots; many very fine pores; 15 percent pebbles, 25 percent cobbles; neutral; clear wavy boundary.

B2-2 to 5 inches; brown (10YR 5/3) very cobbly loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common roots; many medium and few coarse pores; 20 percent pebbles, 30 percent cobbles; neutral; abrupt wavy boundary.

IIR-5 inches; basalt.

The solum is 4 to 10 inches thick. The soils are usually moist, but are dry in all parts between 4 inches and bedrock for 80 to 90 consecutive days. These soils are 35 to 80 percent coarse fragments.

The A horizon has a value of 4 or 5, dry.

The B horizon when dry has value of 4 or 5 and hue of 7.5YR and 10YR. It is loam or clay loam and about 50 percent coarse fragments.

Beckley series

The Beckley series consists of very deep and somewhat excessively drained soils. These soils formed in outwash on terraces and terrace breaks. The elevation is 1,500 to 2,000 feet. The slope is 0 to 55 percent. The average annual precipitation is 12 to 17 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Beckley fine sandy loam, 0 to 7 percent slopes, 2,180 feet north and 1,100 feet east of the southwest corner of sec. 21, T. 21 N., R. 38 E.

A11-0 to 7 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many roots to a depth of 3 inches, common roots to a depth of 7 inches; few very fine pores; pockets, 2 to 3 inches in diameter, of loamy sand; neutral; abrupt smooth boundary.

A12-7 to 12 inches; dark brown (10YR 4/3) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common roots; many very fine pores; neutral; gradual smooth boundary.

B2-12 to 18 inches; yellowish brown (10YR 5/4) sandy loam, dark brown (10YR 3/3) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common roots; many very fine and few fine pores; neutral; gradual smooth boundary.

C1-18 to 24 inches; yellowish brown (10YR 5/4) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common roots; 5 percent pebbles; few very fine pores; mildly alkaline; clear smooth boundary.

IIC2-24 to 60 inches; brown (10YR 5/3) coarse sand, dark brown (10YR 3/3) moist; single grain; loose; neutral; 10 percent pebbles; strongly effervescent on underside of pebbles; mildly alkaline.

Coarse sand is at a depth of 21 to 31 inches. The solum is 15 to 25 inches thick. These soils are usually moist, but are dry in all parts between depths of 8 and 24 inches for 70 to 80 consecutive days. The control section is 0 to 10 percent coarse fragments.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The B horizon has value of 4 or 5, dry, and 2 or 3, moist. It is coarse sandy loam, sandy loam, or fine sandy loam.

The C horizon has value of 4 or 5, dry, and 2 or 3, moist. It is sandy loam, coarse sandy loam, or coarse sand in the lower part.

Benco series

The Benco series consists of very deep and well drained soils. These soils are on terraces. They formed in glacial outwash material that is mixed with loess in the upper part. The elevation is 1,900 to 2,500 feet. The slope is 0 to 7 percent. The average annual precipitation is 12 to 18 inches, and the mean annual temperature is about 52 degrees *F*.

Typical pedon is Benco cobbly silt loam, 0 to 7 percent slopes, 80 feet east and 1,360 feet north of the southwest corner of sec. 15, T. 24 N., R. 35 E.

A1-0 to 10 inches; grayish brown (10YR 5/2) cobbly silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 20 percent cobbles, 10 percent pebbles; neutral; clear wavy boundary.

B2-10 to 20 inches; pale brown (10YR 6/3) very cobbly silt loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; 30 percent pebbles, 25 percent cobbles; neutral; abrupt *wavy* boundary.

C-20 to 60 inches; extremely gravelly loamy coarse sand; loose; single grain; 80 percent pebbles, 10 percent cobbles; some rock fragments have white silica coatings on the lower side; neutral.

The solum is 16 to 28 inches thick. The mollic epipedon is 8 to 14 inches thick. The mean annual soil temperature at a depth of 20 inches is 50 to 55 degrees F. These soils are usually moist but are dry in all parts between depths of 8 and 25 inches for 70 to 90 consecutive days. The control section averages more than 35 percent rock fragments.

The A horizon has value of 4 or 5, dry, and chroma of 2 or 3, moist or dry. It is 15 to 35 percent coarse fragments. The structure is weak granular or weak subangular blocky.

The B horizon has value of 5 or 6, dry, and 3 or 4, moist. It is silt loam or loam. It is less than 50 percent fine sand or coarser material, and less than 18 percent clay, and it is 35 to 60 percent coarse fragments. The structure is weak subangular blocky or weak prismatic.

The C horizon is loamy coarse sand or coarse sand and 35 to 90 percent rounded pebbles and cobbles.

Benge series

The Benge series consists of very deep, well drained soils. These soils are on terraces in the channeled scablands. The soil material in the upper part of the profile formed in loess, and the material in the lower part formed in glacial outwash. The elevation is 1,900 to 2,400 feet. The slope is 0 to 15 percent. The average annual precipitation is 12 to 16 inches, and the mean annual temperature is about 52 degrees *F*.

Typical pedon of Benge silt loam, 0 to 15 percent slopes, 1,740 feet west and 1,480 feet south of the northeast corner of sec. 20, T. 21 N., R. 39 E.

A11-0 to 3 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; mildly alkaline; clear wavy boundary.

A12-3 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 3/2) moist; weak fine and very fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common roots; many very fine pores; mildly alkaline; clear wavy boundary.

A13-7 to 11 inches; dark grayish brown (10YR 4/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; common very fine pores; 15 percent pebbles; mildly alkaline; clear wavy boundary.

B2-11 to 18 inches; brown (10YR 5/3) gravelly silt loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; many fine and coarse pores; 20 percent pebbles; mildly alkaline; gradual wavy boundary.

C1-18 to 25 inches; pale brown (10YR 6/3) gravelly silt loam, dark brown (10YR 4/3) moist; very weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few roots; many fine and coarse pores; 30 percent pebbles; mildly alkaline; clear wavy boundary.

IIC2-25 to 60 inches; extremely gravelly loamy coarse sand; 5 percent cobbles, 90 percent pebbles.

Loamy coarse sand is at a depth of 24 to 40 inches. The solum is 15 to 24 inches thick. The mollic epipedon is 9 to 14 inches thick. These soils are usually moist but are dry in all parts between depths of 8 and 24 inches for 70 to 90 consecutive days. The upper part of the control section is less than 35 percent coarse fragments.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is 0 to 15 percent pebbles.

The B horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist. It is silt loam or loam and 15 to 25 percent pebbles. This horizon has weak subangular blocky or weak prismatic structure.

The C1 horizon has value of 5 or 6, dry, and 3 or 4, moist. It is 20 percent pebbles. The IIC horizon is 50 to 95 percent coarse fragments and is loamy coarse sand or sand.

Broadax series

The Broadax series consists of very deep, well drained soils. These soils formed in loess on uplands. The elevation is 2,200 to 3,000 feet. The slope is 0 to 40 percent. The average annual precipitation is 12 to 18 inches, and the mean annual temperature is about 48 degrees F.

Typical pedon of Broadax silt loam, 7 to 25 percent slopes, 1,600 feet west and 2,200 feet south of the northeast corner of sec. 18, T. 24 N., R. 38 E.

Ap1-0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; few roots; many very fine pores; slightly acid; clear smooth boundary.

Ap2-4 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; soft, very friable, sticky and slightly plastic; few roots; many fine pores; slightly acid; clear smooth boundary.

A13-8 to 16 inches; dark brown (10YR 5/4) silt loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; few very fine pores; neutral; gradual smooth boundary.

B21t-16 to 31 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 3/4) moist; moderate coarse prismatic structure breaking to moderate fine subangular blocky; hard, firm, sticky and plastic; few roots; few very fine pores; thin patchy clay films on faces of peds; mildly alkaline; clear wavy boundary.

B22tca-31 to 35 inches; yellowish brown (10YR 5/4) silt loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure breaking to moderate fine subangular blocky; hard, firm, sticky and slightly plastic; few roots; few fine pores; moderately effervescent; thin carbonate accumulations along faces of peds; moderately alkaline; clear wavy boundary.

C1ca-35 to 44 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots; many fine pores; violently effervescent; carbonate accumulations along cracks and seams; strongly alkaline; clear smooth boundary.

C2ca-44 to 60 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; massive, soft, very friable, slightly sticky and nonplastic; few roots; many fine and common very fine pores; violently effervescent; strongly alkaline.

These soils are usually moist but are dry in all parts between depths of 4 and 12 inches for more than 60 consecutive days in 7 out of 10 years. The argillic horizon is 20 to 35 percent clay and less than 15 percent particles coarser than very fine sand. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 to 3, dry or moist. It is slightly acid or mildly alkaline.

The Bt horizon has value of 5 or 6, dry, and of 3 or 4, moist, and chroma of 3 to 4, dry or moist. It is silt loam to silty clay loam. This horizon is moderately or mildly alkaline.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is mildly alkaline through strongly alkaline.

Burke series

The Burke series consists of moderately deep, well drained soils. These soils formed in loess on broad uplands. The elevation is 1,200 to 1,600 feet. The slope is 0 to 15 percent. The average annual precipitation is 6 to 9 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Burke silt loam, 0 to 15 percent slopes, 220 feet north and 340 feet west of the southeast corner of sec. 26, T. 21 N., R. 31 E.

Ap-0 to 6 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common roots; many very fine pores; mildly alkaline; abrupt smooth boundary.

A12-6 to 8 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse platy structure; slightly hard, very friable, nonsticky and nonplastic; common roots; few fine pores; moderately alkaline; clear wavy boundary.

C1ca-8 to 16 inches; brown (10YR 5/3) silt loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, nonsticky and nonplastic; common roots; common very fine pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

C2ca-16 to 27 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, very firm, slightly sticky and nonplastic; few roots; few very fine pores; many very hard nodules coated with carbonate accumulations; violently effervescent; strongly alkaline; gradual smooth boundary.

C3ca-27 to 36 inches; brown (10YR 5/3) silt loam, dark yellowish brown (10YR 3/4) moist; massive; hard, firm, slightly sticky and nonplastic; few roots; violently effervescent; many hard nodules coated with carbonate accumulations that are pale brown (10YR 6/3) when moist and white (10YR 8/2) when dry; strongly alkaline; abrupt wavy boundary.
C4casim-36 to 60 inches; light gray (10YR 6/1) lime- and silica-cemented duripan.

The duripan is at a depth of 24 to 40 inches. These soils are usually dry but are moist between depths of 4 and 12 inches for at least 60 days. The control section is 5 to 10 percent material coarser than very fine sand.

The A horizon has value of 5 or 6, dry, and 3 or 4, moist. It has weak platy and granular structure. The content of organic matter is less than 1. percent.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist. The duripan is 6 inches to several feet thick.

Chard series

The Chard series consists of very deep and well drained soils. These soils are on terraces along major drainageways. They formed in glacial outwash material and the overlying loess. The elevation is 1,800 to 2,200 feet. The slope is 0 to 15 percent. The average annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Chard silt loam, 0 to 15 percent slopes, 1,140 feet north and 1,600 feet east of the southwest corner of sec. 24, T. 22 N., R. 38 E.

A11-0 to 5 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; few fine and many very fine pores; neutral; abrupt smooth boundary.
A12-5 to 12 inches; dark grayish brown (10YR 4/2) very fine sandy loam, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common roots; few very fine and many very fine pores; neutral; abrupt smooth boundary.
A13-12 to 16 inches; dark brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; common fine and many very fine pores; neutral; clear smooth boundary.
B2-16 to 30 inches; dark yellowish brown (10YR 4/4) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky and slightly plastic; common roots; common fine and many very fine pores; neutral; gradual smooth boundary.
IICca-30 to 60 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; few roots; common very fine and many very fine pores; strongly effervescent; strongly alkaline.

The solum is 20 to 30 inches thick. The mollic epipedon is 11 to 16 inches thick. These soils are usually moist but are dry in all parts between depths of 8 and 24 inches for 70 to 80 consecutive days.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist.

The B2 horizon has value of 4 or 5, dry, and 3 or 4, moist, and chroma of 2 through 4, dry or moist. It is silt loam or very fine sandy loam.

The IIC horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist.

Cheney series

The Cheney series consists of very deep, well drained soils. These soils are on terraces. They formed in glacial outwash that is mixed with loess in the upper part. The elevation is 1,900 to 2,300 feet. The slope is 0 to 5 percent. The average annual precipitation is 15 to 18 inches, and the mean annual temperature is about 47 degrees F.

Typical pedon of Cheney silt loam, 0 to 5 percent slopes, 540 feet east and 160 feet south of the northwest corner of sec. 12, T. 26 N., R. 39 E.

Ap-0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many very fine pores; neutral; abrupt smooth boundary.
A12-8 to 11 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common very fine pores; mildly alkaline, clear smooth boundary.
B21-11 to 25 inches; yellowish brown (10YR 5/4) gravelly silt loam; dark yellowish brown (10YR 3/4) moist; weak medium prismatic structure; hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine pores; 20 percent pebbles; mildly alkaline; clear smooth boundary.
IIC-25 to 30 inches; light yellowish brown (10YR 6/4) extremely gravelly loamy sand, yellowish brown (10YR 5/4) moist; single grain; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; many very fine pores; 70 percent pebbles; moderately alkaline; clear wavy boundary.
IIC2-30 to 60 inches; extremely gravelly coarse sand; single grain; loose; 80 percent pebbles.

The solum is 20 to 36 inches thick. These soils are usually moist but are dry in all parts between depths of 8 and 25 inches for 70 to 90 consecutive days in summer and fall. The mollic epipedon is 10 to 15 inches thick.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and has chroma of 1 or 2, dry or moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist. It is 15 to 30 percent coarse fragments.

The IIC horizon has value of 5 or 6, dry, and 4 or 5, moist. It is 35 to 90 percent coarse fragments.

Cocolalla series

The Cocolalla series consists of very deep, poorly drained soils. These soils are on bottom lands and in basins in the channeled scablands. The soils formed in alluvium that derived from loess and volcanic ash. The elevation is 1,700 to 2,500 feet. The slope is 0 to 3 percent. The average annual precipitation is 14 to 19 inches, and the mean annual temperature is about 47 degrees F.

Typical pedon of Cocolalla silt loam, 85 feet east and 120 feet north of the southwest corner of sec. 15, T. 25 N., R. 35 E.

Ap-0 to 5 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; neutral; clear smooth boundary.

C1g-5 to 22 inches; gray (10YR 5/1) silt loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many roots; mildly alkaline; gradual wavy boundary.

C2g-22 to 53 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common roots; many large pores; neutral; abrupt smooth boundary.

C3g-53 to 60 inches; light gray (10YR 6/1) silt loam, gray (10YR 5/1) moist; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common roots; mildly alkaline.

Typically, these soils are saturated with water for 6 to 8 months in most years. In some areas they are artificially drained. These soils are 60 to 70 percent volcanic ash. Reaction ranges from neutral to mildly alkaline.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The Cg horizon has value of 5 through 8, dry, and 3 through 5, moist. It is very fine sandy loam, silt loam, silty clay loam, and clay loam.

Conconully series

The Conconully series consists of very deep, well drained soils. These soils formed in glacial till on the side slopes of canyons. The elevation is 1,500 to 3,000 feet. The slope is 25 to 55 percent. The average annual precipitation is 11 to 15 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Conconully very stony fine sandy loam, 25. to 55 percent slopes, 500 feet south and 1,200 feet west of the northeast corner of sec. 28, T. 28 N., R. 32 E.

A11-0 to 4 inches; dark grayish brown (10YR.4/2) very stony fine sandy loam, very dark brown (10YR 2/2) moist; weak fine and medium platy structure; soft, very friable, nonsticky and nonplastic; many roots; 10 percent pebbles, 10 percent stones; neutral; abrupt smooth boundary.

A12-4 to 14 inches; grayish brown (10YR 5/2) very stony fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; 10 percent pebbles, 10 percent stones; neutral; gradual smooth boundary.

B2-14 to 40 inches; brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; weak medium prismatic structure; soft, very friable, nonsticky and nonplastic; common roots; few fine pores; 20 percent pebbles, 5 percent cobbles; neutral; gradual wavy boundary.

C1-40 to 51 inches; pale brown (10YR 6/3) gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, nonsticky and nonplastic; common roots; 25 percent pebbles, 5 percent cobbles; mildly alkaline; gradual wavy boundary.

C2-51 to 60 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few roots; 20 percent pebbles, 10 percent cobbles; mildly alkaline.

The solum is 30 to 40 inches thick. These soils are usually moist but are dry in all parts between depths of 8 and 24 inches for 70 to 90 consecutive days. The mollic epipedon is 10 to 14 inches thick.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is 20 to 35 percent coarse fragments.

The B horizon has value of 5 or 6, dry, and 3 or 4, moist. It is fine sandy loam to coarse sandy loam and 20 to 35 percent coarse fragments.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist. It is sandy loam or coarse sandy loam and 20 to 35 percent coarse fragments.

Dragoon series

The Dragoon series consists of moderately deep, well drained soils. These soils are on uplands and buttes. They formed in weathered granite and the overlying loess. The elevation is 2,300 to 3,000 feet. The slope is 0 to 40 percent. The average annual precipitation is 15 to 18 inches, and the mean annual temperature is about 47 degrees F.

Typical pedon of Dragoon silt loam, 7 to 25 percent slopes, 1,120 feet east and 1,280 feet south of the northwest corner of sec. 2, T. 26 N., R. 37 E.

Ap-0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; abundant fine roots; neutral; clear *wavy* boundary.

A12-6 to 11 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few fine pores; neutral; clear wavy boundary.

A13-11 to 16 inches; brown (10YR 5/3) loam, dark brown (10Y 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common fine roots; few fine pores; neutral; clear smooth boundary.

B2t-16 to 23 inches; light brown (7.5YR 6/4) heavy loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine roots; few fine pores; few thin discontinuous clay films on faces of peds; 10 percent pebbles; neutral; clear wavy boundary.

IICr-23 to 60 inches; weathered granite; crumbles to gravelly coarse sand; single grain; loose; 30 percent pebbles; neutral.

The weathered granite is at a depth of 20 to 40 inches. These soils are usually moist but are dry in all parts between depths of 4 and 12 inches for 70 to 80 consecutive days in summer and fall. The mean annual soil temperature is 48 degrees F. The mollic epipedon is 10 to 18 inches thick.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is silt loam or very stony silt loam.

The B2t horizon has hue of 7.5YR or 10YR and value of 5 or 6, dry, and 3 or 4, moist. It is 0 to 15 percent pebbles.

Emdent series

The Emdent series consists of very deep, somewhat poorly drained soils. These soils are on bottom lands and in basins in the channeled scablands. They formed in a mixture of loess and volcanic ash. The elevation is 1,500 to 2,400 feet. The slope is 0 to 3 percent. The average annual precipitation is 9 to 18 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Emdent silt loam, 400 feet west and 2,240 feet south of the northeast corner of sec. 27, T. 26 N., R. 35 E.

A1ca-0 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; violently effervescent; strongly alkaline; gradual wavy boundary.

C1ca-10 to 24 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few medium roots; few fine pores; violently effervescent; strongly alkaline; gradual wavy boundary.

C2-24 to 39 inches; light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common medium and few fine roots; few medium pores; slightly effervescent; moderately alkaline; gradual wavy boundary.

C3-39 to 60 inches; white (10YR 8/2) very fine sandy loam, grayish brown (10YR 5/2) moist; massive; hard, firm, slightly sticky and slightly plastic; moderately alkaline.

The 10- to 40-inch control section is 60 to 80 percent volcanic ash. The water table typically is at a depth of 24 to 40 inches in summer. In some areas the soils have been drained. The mollic epipedon is 8 to 15 inches thick. The profile is moderately to strongly alkaline.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 1 or 2, dry or moist.

The C horizon has value of 6 through 8, dry, and 5 through 7, moist, and chroma of 1 through 3, dry or moist. It is stratified very fine sandy loam or silt loam.

Endicott series

The Endicott series consists of moderately deep, well drained soils. These soils formed in loess on south- and east-facing slopes on uplands. The elevation is 2,300 to 2,600 feet. The slope is 5 to 40 percent. The average annual precipitation is 12 to 15 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Endicott silt loam, 5 to 25 percent slopes, 1,140 feet east and 620 feet north of the southwest corner of sec. 21, T. 23 N., R. 37 E.

Ap-0 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many very fine pores; neutral; abrupt smooth boundary.

B21-10 to 21 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many very fine and few fine pores; mildly alkaline; clear wavy boundary.

B22ca-21 to 24 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak medium prismatic structure; hard, friable, sticky and plastic; common roots; many very fine and few fine pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

C1ca-24 to 30 inches; white (10YR 8/2) silt loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few roots;

common very fine and few fine pores; violently effervescent; strongly alkaline; clear smooth boundary.

C2sim-30 to 60 inches; layers of indurated lime-silica cemented hardpan lenses separated by white (10YR 8/2) silt loam loess that is pale brown (10YR 6/3) moist; violently effervescent; strongly alkaline silt loam loess.

The duripan is at a depth of 20 to 40 inches. The solum is 19 to 30 inches thick. The mollic epipedon is 10 to 14 inches thick. These soils are usually moist but are dry between depths of 4 and 12 inches for 80 to 90 consecutive days. In some places, basalt is below the duripan.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist. It has weak medium and coarse prismatic structure.

The C horizon has value of 6 through 8, dry, and 5 or 6, moist, and chroma of 2 or 3, dry or moist.

Esquatzel series

The Esquatzel series consists of very deep, well drained soils. These soils are on bottom lands. They formed in alluvium that derived from loess. The elevation is 1,400 to 2,000 feet. The slope is 0 to 2 percent, The average annual precipitation is 6 to 12 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Esquatzel silt loam, 40 feet south and 890 feet west of the northeast corner of sec. 17, T. 26 N., R. 32 E.

Ap1-0 to 3 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many roots; few medium, common very fine, and many micro pores; neutral; abrupt smooth boundary.

Ap2-3 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium platy structure (tillage pan); hard, friable, nonsticky and nonplastic; common roots; few fine, common very fine, and many micro pores; neutral; abrupt smooth boundary.

C1-10 to 17 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common roots; few fine pores; mildly alkaline; gradual smooth boundary.

C2-17 to 31 inches; brown (10YR 5/3) silt loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common roots; common fine and very fine pores; moderately alkaline; clear smooth boundary.

C3-31 to 37 inches; brown (10YR 5/3) silt loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few roots; few medium, fine, and very fine pores; moderately alkaline; clear smooth boundary.

C4-37 to 60 inches; brown (10YR 5/3) silt loam, dark yellowish brown (10YR 3/4) moist; massive; hard, friable, slightly sticky and nonplastic; few roots; few fine and common very fine pores; slightly effervescent; moderately alkaline.

These soils are usually dry at least half the time the soil temperature at a depth of 20 inches is above 41 degrees F.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 through 4, dry or moist. In places, it has lenses of fine sandy loam.

Ewall series

The Ewall series consists of very deep, excessively drained soils. These soils formed in outwash sands on terraces along the Columbia and Spokane Rivers. The elevation is 1,300 to 1,500 feet. The slope is 0 to 55 percent. The average annual precipitation is 12 to 18 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Ewall loamy sand, 0 to 15 percent slopes, 1,300 feet west and 2,580 feet north of the southeast corner of sec. 27, T. 27 N., R. 37 E.

O1-1 inch to 0; undecomposed pine needles and twigs; abrupt smooth boundary.

A1-0 to 6 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; very weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and few medium roots; neutral; clear smooth boundary.

C1-6 to 15 inches; pale brown (10YR 6/3) sand, dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; few medium roots; neutral; gradual smooth boundary.

C2-15 to 54 inches; pale brown (10YR 6/3) sand, dark brown (10YR 4/3) moist; single grain; loose; few medium roots; neutral; gradual smooth boundary.

C3-54 to 60 inches; pale brown (10YR 6/3) sand, dark brown (10YR 4/3) moist; single grain; loose; few medium roots; neutral.

These soils are usually moist but are dry in all parts between depths of 12 and 35 inches for 70 to 90 consecutive days.

The A horizon has value of 5 or 6, dry, and 3 or 4, moist.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2, 3, or 4, dry or moist.

Farrell series

The Farrell series consists of very deep, well drained soils. These soils are on terraces and terrace fronts. They formed in glacial outwash that is mixed with loess in the upper part. The elevation is 1,500 to 2,100 feet. The slope is 0 to 25 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 51 degrees F.

Typical pedon of Farrell very fine sandy loam, 0 to 5 percent slopes, 400 feet east and 200 feet north of the southwest corner of sec. 18, T. 21 N., R. 33 E.

Ap-0 to 5 inches; brown (10YR 5/3) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse granular structure; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; mildly alkaline; clear smooth boundary.

A12-5 to 14 inches; brown (10YR 5/3) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; few roots; common very fine pores; tillage pan that has weak thin platy structure is at a depth of 5 to 7 inches; mildly alkaline; clear smooth boundary.

B2-14 to 26 inches; pale brown (10YR 6/3) very fine sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, friable, nonsticky and nonplastic; few roots; common very fine pores; mildly alkaline; clear smooth boundary.

C1ca-26 to 32 inches; pale brown (10YR 6/3) coarse sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; few roots; many very fine pores; 3 percent pebbles, 5 percent silica-cemented caliche fragments; strongly effervescent; strongly alkaline; clear smooth boundary.

C2ca-32 to 41 inches; pale brown (10YR 6/3) coarse sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; no roots; many very fine pores; 3 percent pebbles, 7 percent silica-cemented caliche fragments; violently effervescent; strongly alkaline; clear smooth boundary.

IIC3ca-41 to 51 inches; light brownish gray (10YR 6/2) sand, dark grayish brown (10YR 4/2) moist; single grain; loose; many very fine pores; 3 percent silica-cemented caliche fragments; violently effervescent; strongly alkaline; abrupt wavy boundary.

IIC4ca-51 to 60 inches; pale brown (10YR 6/3) coarse sand, dark grayish brown (10YR 4/2) moist; single grain; loose; many very fine pores; 5 percent pebbles; 1 percent silica-cemented caliche fragments; violently effervescent; strongly alkaline.

The thickness of the solum and the depth to secondary carbonates are 23 to 30 inches. These soils are usually dry between depths of 8 and 24 inches.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist. It is very fine sandy loam or fine sandy loam.

The B horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist. It is loam, very fine sandy loam, or silt loam.

The Cca horizon has value of 6 or 7, dry, and 4 or 5, moist, and chroma of 2 or 3, dry or moist. It is stratified coarse sandy loam or fine sandy loam and is 0 to 10 percent coarse fragments. It is moderately alkaline to strongly alkaline.

The IIC horizon has value of 4 through 7, dry, and 2 through 6, moist. It is coarse and medium sand.

Hanning series

The Hanning series consists of very deep, well drained soils. These soils formed in loess on uplands. The elevation is 2,300 to 3,000 feet. The slope is 0 to 25 percent. The average annual precipitation is 15 to 18 inches, and the mean annual temperature is about 48 degrees F.

Typical pedon of Hanning silt loam, 0 to 7 percent slopes, 20 feet east and 80 feet north of the southwest corner of sec. 4, T. 24 N., R. 38 E.

Ap1-0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; neutral; abrupt smooth boundary.

Ap2-4 to 11 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine pores; neutral; clear smooth boundary.

A13-11 to 21 inches; brown (10YR 4/3) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; mildly alkaline; clear smooth boundary.

B21t-21 to 27 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium prismatic structure breaking to weak medium blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine pores; mildly alkaline; abrupt smooth boundary.

B22t-27 to 38 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; hard, friable, sticky and plastic; common very fine roots; few very fine pores; common thin clay skins on faces of peds; mildly alkaline; clear smooth boundary.

B23t-38 to 49 inches; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; hard, friable, slightly sticky and slightly plastic; common very fine

roots; common very fine pores; very few thin clay skins on faces of peds; mildly alkaline; clear smooth boundary.

C-49 to 60 inches; pale brown (10YR 6/3) silt loam, dark yellowish brown (10YR 4/4) moist; massive; soft, friable, slightly sticky and slightly plastic; few fine roots; few very fine pores; mildly alkaline.

The mollic epipedon is 21 to 33 inches thick. These soils are usually moist but are dry in all parts between depths of 4 and 12 inches for 70 to 80 consecutive days following the summer solstice. They are neutral to moderately alkaline. The control section is 18 to 27 percent clay and less than 15 percent fine sand or coarser material.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist. It has weak or moderate granular structure.

The B horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It has weak to moderate prismatic or blocky structure.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist.

Hesseltine series

The Hesseltine series consists of very deep, well drained soils. These soils are on terraces in the channeled scablands. They formed in glacial outwash and the overlying loess. The elevation is 2,000 to 2,300 feet. The slope is 0 to 15 percent. The average annual precipitation is 17 to 20 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Hesseltine silt loam, 0 to 15 percent slopes, 2,620 feet west and 40 feet north of the southeast corner of sec. 26, T. 27 N., R. 39 E.

O1-1 inch to 0; partially decomposed pine needles, leaves, twigs, and cones; abrupt smooth boundary.

A11-0 to 3 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; many fine and medium roots; few fine and many very fine pores; 5 percent cobbles; neutral; clear wavy boundary.

A12-3 to 7 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many fine and medium roots; few fine and many very fine pores; 5 percent cobbles, 5 percent pebbles; neutral; clear wavy boundary.

B21t-7 to 12 inches; brown (7.5YR 5/4) silt loam, dark brown (7.5YR 4/4) moist; moderate medium prismatic structure breaking to moderate fine subangular blocky; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; few fine and many very fine pores; few thin clay films on faces of peds; 5. percent cobbles, 5 percent pebbles; neutral; gradual wavy boundary.

B22t-12 to 20 inches; brown (7.5YR 5/4) very gravelly silt loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; few fine and medium pores; very few thin clay films on faces of peds; 1 percent stones, 5 percent cobbles, 40 percent pebbles; neutral; gradual wavy boundary.

IIC1-20 to 24 inches; very gravelly coarse sand; single grain; loose; common fine roots; many fine and very fine pores; 35 percent pebbles, 15 percent cobbles; neutral; gradual wavy boundary.

IIC2-24 to 60 inches; extremely gravelly coarse sand; single grain; loose; 15 percent cobbles, 60 percent pebbles.

The thickness of the solum and the depth to the very gravelly coarse sand are 14 to 30 inches. The mollic epipedon is 7 to 14 inches thick. The control section is 15 to 35 percent coarse fragments. These soils are usually moist but are dry in all parts between depths of 8 and 24 inches for 65 to 80 consecutive days.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5, dry, and 3 or 4, moist and chroma of 2 or 3. It is 0 to 15 percent coarse fragments.

The B2t horizon is silt loam or loam. It is 0 to 15 percent coarse fragments in the upper part and 25 to 50 percent in the lower part. By weighted average, the content of coarse fragments in the argillic horizon ranges from 15 to 35 percent. This horizon has value of 4 or 5, dry, and 3 or 4, moist, and hue of 10YR or 7.5YR.

The IIC horizon is coarse sand and 35 to 90 percent coarse fragments.

Kuhl series

The Kuhl series consists of shallow, well drained soils. These soils are on canyon breaks along major drainageways and on basalt plateaus. They formed in a mixture of loess and colluvium that derived from basalt. The elevation is 1,700 to 2,200 feet. The slope is 0 to 15 percent. The average annual precipitation is 12 to 18 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Kuhl cobbly silt loam, 0 to 15 percent slopes, 400 feet west and 1,800 feet south of the northeast corner of sec. 22, T. 25 N., R. 36 E.

A11-0 to 4 inches; grayish brown (10YR 5/2) cobbly silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable, nonsticky and slightly plastic; many roots; many very fine pores; 5 percent pebbles, 15 percent cobbles; neutral; clear wavy boundary.

A12-4 to 8 inches; brown (10YR 5/3) cobbly silt loam, dark brown (10YR 3/3) moist; weak fine subangular

blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many very fine pores; 5 percent pebbles, 15 percent cobbles; neutral; clear wavy boundary.

B2-8 to 12 inches; brown (10YR 5/3) cobbly silt loam, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common roots; common very fine pores; 5 percent pebbles, 15 percent cobbles; neutral; abrupt wavy boundary.

IIR-12 inches; basalt.

The thickness of the solum and the depth to bedrock are 10 to 20 inches. The mollic epipedon is 7 to 11 inches thick. The control section is 10 to 35 percent coarse fragments. These soils are usually moist but are dry in all parts for 70 to 90 consecutive days.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is 15 to 20 percent coarse fragments.

The B horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist.

Lance series

The Lance series consists of very deep, well drained soils. These soils are on south-facing slopes on uplands. They formed in calcareous loess. The elevation is 2,500 to 2,800 feet. The slope is 7 to 25 percent. The average annual precipitation is 15 to 18 inches, and the mean annual temperature is about 47 degrees F.

Typical pedon of Lance silt loam, 7 to 25 percent slopes, 1,600 feet west and 2,120 feet south of the northeast corner of sec. 31, T. 25 N., R. 39 E.

Ap-0 to 8 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; abundant very fine roots; many very fine pores; 5 percent hard and firm durinodes; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C1sica-8 to 18 inches; very pale brown (10YR 7/3) silt loam, dark brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and nonplastic; common roots; common very fine pores; 40 percent cemented durinodes, hard, firm; strongly effervescent; strongly alkaline; abrupt wavy boundary.

C2sica-18 to 22 inches; very pale brown (10YR 7/3) silt loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, slightly sticky and nonplastic; very few roots; 45 percent hard and firm durinodes; violently effervescent; strongly alkaline; gradual wavy boundary.

B2bsica-22 to 41 inches; very pale brown (10YR 7/3) silt loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and nonplastic; very few roots; many fine pores; 35 percent white (10YR 8/2) strong angular blocks; violently effervescent; strongly alkaline; gradual wavy boundary.

B3bsica-41 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; very hard, very firm, nonsticky and nonplastic; few micro roots; common very fine pores; violently effervescent; 50 percent 1/2 inch white (10YR 8/2) very brittle silica-cemented carbonates; strongly alkaline.

The Csica horizon is at a depth of 6 to 10 inches. These soils are usually moist but are dry in all parts between depths of 4 and 12 inches for 70 to 90 consecutive days in summer and fall. The control section averages 18 to 25 percent clay.

The Ap horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist, but never a value of both 5, dry, and 3, moist.

The Csica horizon has value of 6 or 7, dry, and 3 or 4, moist, and chroma of 2 through 4, dry or moist. It is 40 to 60 percent durinodes that are very hard, very firm, and approximately 1 inch in diameter.

The Bbsica horizon has value of 6 or 7, dry, and 5 or 6, moist, and chroma of 3 or 4, dry or moist.

Mondovi series

The Mondovi series consists of very deep, well drained soils. These soils are on bottom lands. They formed in alluvium that derived from loess. The elevation is 2,000 to 2,500 feet. The slope is 0 to 3 percent. The average annual precipitation is 16 to 20 inches, and the mean annual temperature is about 52 degrees F.

Typical pedon of Mondovi silt loam, 2,000 feet west and 1,010 feet north of the southeast corner of sec. 19, T. 25 N., R. 38 E.

Ap-0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; mildly alkaline; abrupt smooth boundary.

A11-7 to 15 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine and very fine pores; mildly alkaline; abrupt smooth boundary.

A12-15 to 60 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; mildly alkaline.

The mollic epipedon is more than 60 inches thick. The mean annual soil temperature ranges from 49 to 53 degrees F. These soils are usually moist but are dry in

all parts between depths of 4 and 12 inches for 60 to 80 consecutive days. The control section is less than 18 percent clay.

The Ap horizon has chroma of 1 or 2, moist or dry. It has weak or moderate granular structure. This horizon is mildly alkaline or neutral.

The A1 horizon has chroma of 1 or 2, moist or dry.

Nespelem series

The Nespelem series consists of very deep, well drained soils. These soils are on dissected terraces. They formed in calcareous lake sediments and the overlying loess. The elevation is 1,300 to 2,000 feet. The slope is 3 to 45 percent. The average annual precipitation is 15 to 18 inches, and the mean annual temperature is about 46 degrees F.

Typical pedon of Nespelem silt loam, 3 to 15 percent slopes, 2,060 feet west and 860 feet north of the southeast corner of sec. 19, T. 27 N., R. 36 E.

Ap-0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable, slightly sticky and nonplastic; many fine roots; many very fine pores; neutral; clear smooth boundary.

A12-7 to 13 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common fine roots; few fine and very fine pores; neutral; clear wavy boundary.

A13-13 to 17 inches; grayish brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; common fine and many very fine pores; neutral; clear wavy boundary.

B2-17 to 25 inches; pale brown (10YR 6/3) very fine sandy loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine and common very fine pores; mildly alkaline; abrupt wavy boundary.

C1-25 to 29 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine roots; few coarse and fine pores; mildly alkaline; abrupt wavy boundary.

IIC2ca-29 to 36 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; hard, firm, slightly sticky and nonplastic; few fine roots; few fine and common very fine pores; slightly effervescent; moderately alkaline; clear wavy boundary.

IIC3ca-36 to 48 inches; pale yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable, sticky and plastic; few roots; few fine and many very fine pores; slightly effervescent; moderately alkaline; gradual smooth boundary.

IIC4ca-48 to 60 inches; pale yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak thick platy structure; slightly hard, very friable, sticky and plastic; few roots; few medium and fine pores; strongly effervescent; moderately alkaline.

The solum is 20 to 30 inches thick. Calcareous lake sediments are at a depth of 20 to 36 inches. The mollic epipedon is 16 to 20 inches thick.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 1 or 2 dry or moist. It has weak to moderate structure.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist. It is silt loam or very fine sandy loam.

The C horizon has hue of 10YR or 2.5Y and value of 6 or 7, dry, and 4 or 5, moist. It is silt loam, very fine sandy loam, and silty clay loam.

Onyx series

The Onyx series consists of very deep, well drained soils. These soils are on bottom lands. They formed in alluvium that derived from loess. The elevation is 1,700 to 2,500 feet. The slope is 0 to 2 percent. The average annual precipitation is 12 to 16 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Onyx silt loam, 680 feet south and 840 feet west of the northeast corner of sec. 36, T. 27 N., R. 32 E.

Ap-0 to 9 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; many roots; neutral; abrupt smooth boundary.

A12-9 to 23 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak thick platy structure; soft, friable, slightly sticky and slightly plastic; many very fine pores; many roots; neutral; clear smooth boundary.

C1-23 to 39 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; common fine pores; mildly alkaline; clear smooth boundary.

C2-39 to 45 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots; common fine pores; mildly alkaline; clear smooth boundary.

C3-45 to 60 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard; friable, slightly sticky and slightly plastic; few roots; many fine and few medium pores; mildly alkaline.

The mollic epipedon is 20 to 30 inches thick. The soil is usually moist but is dry in all parts between depths of 4 and 12 inches for 70 to 90 consecutive days.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist.

Patit Creek Variant

The Patit Creek Variant consists of very deep, well drained soils. These soils are on bottom lands. They formed in alluvium that derived from a mixture of loess and fragments of basalt. The elevation is 2,000 to 2,800 feet. The slope is 0 to 3 percent. The average annual precipitation is 16 to 20 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Patit Creek Variant silt loam, 2,420 feet north and 1,320 feet east of the southwest corner of sec. 8, T. 25 N., R. 36 E.

Ap-0 to 13 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine pores; few earthworm casts; mildly alkaline; abrupt smooth boundary.

A11-13 to 23 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many fine and common very fine pores; 10 percent pebbles; mildly alkaline; clear wavy boundary.

A12-23 to 30 inches; dark grayish brown (10YR 4/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many fine and common very fine pores; 10 percent cobbles, 10 percent pebbles; mildly alkaline; clear wavy boundary.

A13-30 to 38 inches; dark grayish brown (10YR 4/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many fine and common very fine pores; 15 percent cobbles, 15 percent pebbles; mildly alkaline; abrupt smooth boundary.

IIC-38 to 60 inches; brown (10YR 5/3) very gravelly coarse sand, dark brown (10YR 4/3) moist; single grain; loose; many very fine roots; 35 percent pebbles, 15 percent cobbles; 2 percent stones; mildly alkaline.

Very gravelly coarse sand is at a depth of 30 to 40 inches. The mollic epipedon is 30 to 40 inches thick. These soils are usually moist but are dry in all parts between depths of 8 and 25 inches for 70 to 90 consecutive days. The control section is 20 to 30 percent rock fragments.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is 0 to 30 percent coarse fragments.

The IIC horizon has value of 5 or 6, dry, and 3 or 4, moist. It is 35 to 60 percent rock fragments.

Pedigo series

The Pedigo series consists of very deep, somewhat poorly drained soils. These soils are on bottom lands. They formed in alluvium that derived from a mixture of loess and volcanic ash. The elevation is 1,500 to 2,400 feet. The slope is 0 to 3 percent. The average annual precipitation is 10 to 16 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Pedigo silt loam, 2,200 feet east and 2,600 feet north of the southwest corner of sec. 24, T. 25 N., R. 37 E.

A11-0 to 3 inches; grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky and nonplastic; many roots; many very fine pores; slightly effervescent; very strongly alkaline; abrupt wavy boundary.

A12-3 to 11 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; many roots; many very fine pores; slightly effervescent; very strongly alkaline; abrupt smooth boundary.

A13-11 to 22 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common roots to a depth of 15 inches, few below; few fine and many very fine pores; strongly effervescent; very strongly alkaline; gradual smooth boundary.

C1-22 to 29 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few roots; many very fine, common fine, and few medium pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

C2-29 to 60 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few roots; many very fine, common fine, and few medium pores; moderately alkaline.

The mollic epipedon is 20 to more than 40 inches thick. These soils are usually moist but are dry in all parts between depths of 4 and 12 inches for 70 to 80 consecutive days. Reaction is moderately alkaline to strongly alkaline.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist.

Phoebe series

The Phoebe series consists of very deep, well drained soils. These soils formed in glacial outwash on terraces. The elevation is 1,500 to 2,000 feet. The slope is 0 to 15 percent. The average annual precipitation is 16 to 20 inches, and the mean annual temperature is about 47 degrees F.

Typical pedon of Phoebe sandy loam, 0 to 15 percent slopes, 1,400 feet east and 1,680 feet south of the northwest corner of sec. 17, T. 26 N., R. 35 E.

Ap-0 to 5 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; many very fine pores; neutral; abrupt wavy boundary.

A12-5 to 14 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; many very fine pores; neutral; gradual smooth boundary.

B2-14 to 23 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; few fine roots; many very fine pores; neutral; gradual smooth boundary.

C1-23 to 46 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; many very fine pores; neutral; gradual smooth boundary.

C2-46 to 60 inches; yellowish brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; many very fine pores; neutral.

The solum is 20 to 30 inches thick. The mollic epipedon is 12 to 20 inches thick. These soils are usually moist but are dry in all parts between depths of 8 and 24 inches for 60 to 70 consecutive days in summer.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 1 or 2, dry or moist.

The B2 horizon has value of 4 or 5, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is fine sandy loam or sandy loam.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist. It is sandy loam, loamy sand, and sand.

Reardan series

The Reardan series consists of very deep, well drained soils. These soils are on uplands. They formed in loess and in residuum of basalt. The elevation is 1,500 to 2,500 feet. The slope is 0 to 40 percent. The average annual precipitation is 16 to 18 inches, and the mean annual temperature .is about 47 degrees F.

Typical pedon of Reardan silt loam, 7 to 25 percent slopes, 200 feet east and 2,360 feet south of the northwest corner of sec. 12, T. 24 N., R. 39 E.

Ap-0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, very friable; slightly sticky and slightly plastic; many roots; few fine pores; neutral; abrupt smooth boundary.

A12-7 to 13 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; common roots; few fine pores; thin siliceous coatings along faces of peds; mildly alkaline; abrupt boundary.

B1-13 to 23 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common. roots; common fine pores; siliceous coatings along faces of peds; mildly alkaline; abrupt wavy boundary.

B2t-23 to 35 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; strong coarse medium prismatic structure; very hard, very firm, very sticky and very plastic; few roots; many very fine pores; thin continuous clay films on faces of peds; few manganese stains along faces of peds; moderately alkaline; abrupt wavy boundary.

B3tca-35 to 60 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium and fine angular blocky structure; hard, firm, sticky and plastic; few roots; thin patchy clay films on faces of peds; common very fine pores; slightly effervescent, carbonate accumulations in root channels; few manganese stains along faces of peds; moderately alkaline.

Carbonate accumulations are at a depth of 24 to 35 inches. The mollic epipedon is 10 to 15 inches thick. These soils are usually moist but are dry in all parts between depths of 4 and 12 inches for 60 to 80 consecutive days.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 1 or 2.

The B horizon has hue of 10YR and 7.5YR, value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4. It is silty clay loam or silty clay and is 35 to 45 percent clay. It is mildly alkaline and moderately alkaline.

Renslow series

The Renslow series consists of very deep, well drained soils. These soils formed in loess on broad ridgetops on uplands. The elevation is 1,500 to 2,400 feet. The slope is 0 to 25 percent. The average annual precipitation is 10 to 13 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Renslow silt loam, 0 to 5 percent slopes, 310 feet east and 170 feet north of the southwest corner of sec. 23, T. 25 N., R. 32 E.

Ap-0 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; mildly alkaline; abrupt smooth boundary.

B1-10 to 18 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak medium and coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; common fine tubular pores; mildly alkaline; clear *wavy* boundary.

B2t-18 to 28 inches; brown (10YR 5/3) silt loam with thin organic stains on surfaces of peds, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, friable, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; common roots; many fine tubular pores; moderately alkaline; clear wavy boundary.

C1ca-28 to 38 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few roots; common fine tubular pores; carbonate material in root channels and in matrix; strongly effervescent; strongly alkaline; clear wavy boundary.

C2ca-38 to 46 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few roots; common fine tubular pores; strongly effervescent; carbonate material in root channels and in matrix; strongly alkaline; abrupt wavy boundary.

C3ca-46 to 60 inches; light yellowish brown (10YR 6/4) silt loam, dark brown (10YR 4/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few roots; many fine tubular pores; violently effervescent; carbonate material in pores and root channels; strongly alkaline.

The solum is 20 to 44 inches thick. The average annual soil temperature at a depth of 20 inches is 47 degrees to 59 degrees F. These soils are dry between depths of 4 and 12 inches more than half the time the soil temperature at a depth of 20 inches is above 40 degrees F. Reaction is mildly alkaline to strongly alkaline. Secondary lime is at a depth of 20 to 44 inches. The control section is less than 18 percent clay and less than 15 percent fine sand or coarser material. The base saturation throughout the profile is greater than 75 percent.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist. The content of organic matter ranges from 1 to 2.5 percent.

The B horizon has value of 4, 5, or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It has weak or moderate prismatic or blocky structure.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It has weak blocky structure or is massive.

Ritzville series

The Ritzville series consists of very deep, well drained soils. These soils formed in loess on uplands. The elevation is 1,300 to 2,000 feet. The slope is 0 to 25 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Ritzville silt loam, 0 to 5 percent slopes, 180 feet west and 1,840 feet south of the northeast corner of sec. 35, T. 22 N., R. 33 E.

Ap-0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and nonplastic; many roots; few fine pores; mildly alkaline; abrupt smooth boundary.

B1-6 to 16 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; common roots; many fine pores; mildly alkaline; clear wavy boundary.

B2-16 to 34 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and nonplastic; few roots; many fine pores; mildly alkaline; gradual wavy boundary.

C1ca-34 to 49 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and nonplastic; few roots; few fine pores; strongly effervescent; strongly alkaline; gradual wavy boundary.

C2ca-49 to 60 inches; yellowish brown (10YR 5/4) silt loam, dark brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and nonplastic; few fine tubular pores; violently effervescent; strongly alkaline.

The thickness of the solum and the depth to carbonate accumulations are 30 to 43 inches. The mollic epipedon is 10 to 16 inches. This soil is usually dry in all parts between depths of 4 and 12 inches for 90 consecutive days following the summer solstice.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist. It is neutral or mildly alkaline.

The B2 horizon has value of 4 or 5, dry, and 3 or 4, moist. It has weak prismatic or subangular blocky structure and is neutral or mildly alkaline.

The C horizon has value of 5 or 6, dry, and 4 or 5, moist. It is moderately or strongly alkaline.

Roloff series

The Roloff series consists of moderately deep, well drained soils that formed in loess over basalt. These soils are on plateaus. The elevation is 1,300 to 1,700 feet. The slope is 0 to 15 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Roloff silt loam, 0 to 5 percent slopes, 1,600 feet east and 2,440 feet south of the northwest corner of sec. 26, T. 23 N., R. 32 E.

A1-0 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; few fine pores; neutral; gradual wavy boundary.

B2-8 to 15 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; few fine pores; 10 percent pebbles; mildly alkaline; gradual wavy boundary.

C-15 to 23 inches; brown (10YR 5/3) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; few fine pores; 10 percent pebbles; mildly alkaline; abrupt smooth boundary.

IIR-23 inches; basalt.

Bedrock is at a depth of 20 to 40 inches. The solum is 13 to. 25 inches thick. These soils are usually dry in all parts between depths of 8 and 24 inches. The mollic epipedon is 7 to 10 inches thick. The control section averages 5 to 25 percent coarse fragments.

The A horizon has value of 4 or 5, dry, and chroma of 2 or 3, dry or moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist. It is silt loam or very fine sandy loam.

The C horizon has hue of 7.5YR and 10YR, value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 through 4, dry or moist. It is silt loam or very fine sandy loam.

Shano series

The Shano series consists of very deep, well drained soils. These soils formed in loess on uplands. The elevation is 1,300 to 1,700 feet. The slope is 0 to 15 percent. The average annual precipitation is 6 to 9 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Shano silt loam, 0 to 15 percent slopes, 640 feet north and 2,500 feet east of the southwest corner of sec. 27, T. 21 N., R. 31 E.

Ap-0 to 6 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak fine and medium granular structure; slightly hard, very friable, slightly sticky and nonplastic; many roots; many very fine pores; mildly alkaline; clear wavy boundary.

B2-6 to 22 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak medium and coarse prismatic structure; slightly hard, friable, slightly sticky and nonplastic; common roots; few fine and very fine pores; mildly alkaline; gradual smooth boundary.

C1-22 to 33 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common roots; common very fine pores; moderately alkaline; abrupt wavy boundary.

C2ca-33 to 60 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; few roots; many very fine pores; violently effervescent; strongly alkaline.

Carbonate accumulations are at a depth of 24 to 36 inches. The solum is 15 to 25 inches thick. These soils are dry in all parts between depths of 4 and 12 inches from May 1 to October 1.

The Ap horizon has value of 5 or 6, dry, and 4 or 5, moist, and chroma of 2 or 3, dry or moist. It is mildly alkaline or moderately alkaline.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist. It is mildly or moderately alkaline.

The C horizon has value of 6 or 7, dry, and 4 or 5, moist, and chroma of 2 or 3, dry or moist.

Speigle series

The Speigle series consists of very deep, well drained soils. These soils are on steep canyon side slopes. They formed in a mixture of colluvium that derived from basalt and loess. The elevation is 1,400 to 2,600 feet. The slope is 25 to 55 percent. The average annual precipitation is 16 to 20 inches, and the mean annual temperature is about 46 degrees F.

Typical pedon of Speigle very stony silt loam, 25 to 55 percent slopes, 800 feet north and 1,820 feet east of the southwest corner of sec. 1, T. 26 N., R. 38 E.

O1-1 inch to 0; layer of needles, leaves, and twigs.

A1-0 to 4 inches; grayish brown (10YR 5/2) very stony silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable,

slightly sticky and nonplastic; many roots; many fine pores; 5 percent stones, 10 percent pebbles, 15 percent cobbles; neutral; clear smooth boundary.

B2-4 to 14 inches; brown (10YR 5/3) very stony loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many roots; few fine pores; 15 percent stones, 10 percent pebbles, 15 percent cobbles; neutral; clear wavy boundary.

C1-14 to 32 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; many roots to a depth of 16 inches, common roots to a depth of 25 inches, and few below; few fine pores; 2 percent stones, 15,percent pebbles, 40 percent cobbles; neutral; gradual wavy boundary.

C2-32 to 60 inches; brown (10YR 5/3) very cobbly loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few roots; few fine pores; 20 percent pebbles; 30 percent cobbles; neutral.

Angular fragments of basalt make up 35 to 80 percent of the profile. These soils are usually moist but for 60 to 80 consecutive days are dry in all parts between depths of 8 and 24 inches.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist.

The C horizon has value of 5 or 6, dry, and 4 or 5 moist, and chroma of 3 or 4, dry or moist.

Spens series

The Spens series consists of very deep, somewhat excessively drained soils. These soils formed in glacial outwash on terrace breaks. The elevation is 1,400 to 1,800 feet. The slope is 25 to 50 percent. The average annual precipitation is 17 to 20 inches, and the mean annual temperature is about 47 degrees F.

Typical pedon of Spens extremely gravelly loamy sand, 25 to 50 percent slopes, 3,200 feet north and 220 feet west of the southeast corner of sec. 22, T. 27 N., R. 37 E.

A1-0 to 5 inches; grayish brown (10YR 5/2) extremely gravelly loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable, slightly sticky and nonplastic; many fine roots; 2 percent cobbles, 60 percent pebbles; neutral; clear wavy boundary.

C1-5 to 15 inches; brown (10YR 5/3) extremely gravelly loamy sand, dark brown (10YR 4/3) moist; single grain; loose; common fine roots; 10 percent cobbles, 60 percent pebbles; neutral; clear wavy boundary.

C2-15 to 60 inches; brown (10YR 5/3) extremely gravelly loamy sand, dark yellowish brown (10YR 3/4) moist; single grain; loose; few fine roots; 10 percent cobbles, 60 percent pebbles; neutral.

The control section is 60 to 80 percent coarse fragments. These soils are usually moist but for 60 to 80 consecutive days are dry in all parts between depths of 12 and 35 inches.

The A horizon has value of 5 or 6, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist. It is 60 to 80 percent coarse fragments.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is loamy sand or loamy coarse sand and 60 to 80 percent coarse fragments.

Spokane series

The Spokane series consists of moderately deep, well drained soils. These soils are on foothills. They formed in weathered granite and the overlying loess. The elevation is 1,800 to 3,000 feet. The slope is 0 to 55 percent. The average annual precipitation is 18 to 24 inches, and the mean annual temperature is about 46 degrees F.

Typical pedon of Spokane loam, 5 to 30 percent slopes, 1,300 feet west and 580 feet north of the southeast corner of sec. 15, T. 28 N., R. 36 E.

O1-1 inch to 0; leaves, needles, and twigs.

A1-0 to 8 inches; grayish brown (10YR 5/2) loam, very dark brown (10YR 2/2) moist; strong very fine granular structure in upper 1 inch, moderate fine and very fine granular structure below; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; 10 percent pebbles; neutral; clear smooth boundary.

B2-8 to 17 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common roots to a depth of 12 inches, few to a depth of 17 inches; common very fine pores; few fine distinct dark brown (7.5YR 4/4) and few fine faint yellowish brown (10YR 5/4) mottles; 20 percent pebbles; neutral; gradual wavy boundary.

C1-17 to 36 inches; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; massive slightly hard, very friable, nonsticky and nonplastic; few roots; few fine pores; few fine faint dark yellowish brown (10YR 4/4) and few fine distinct dark brown (7.5YR 4/4) mottles; 30 percent pebbles; neutral; abrupt wavy boundary.

C2r-36 inches; weathered granite crumbles to gravelly coarse sand; few roots; 30 percent pebbles.

Disintegrating granite is at a depth of 20 to 40 inches. The solum is 12 to 21 inches thick. The control section

is 15 to 35 percent rock fragments. The mollic epipedon is 7 to 12 inches thick. These soils are usually moist, but in summer and early in autumn they are dry in all parts between depths of 8 and 24 inches for 60 to 80 consecutive days.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist. It is 0 to 10 percent rock fragments.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is loam to coarse sandy loam and is 15 to 30 percent rock fragments.

The C1 horizon has value of 6 or 7, dry, and 4 or 5, moist, and chroma of 3 or 4, dry or moist. It is sandy loam or coarse sandy loam with 15 to 30 percent rock fragments.

Springdale series

The Springdale series consists of very deep, somewhat excessively drained soils. These soils formed in glacial outwash on terraces. The elevation is 1,400 to 1,800 feet. The slope is 0 to 15 percent. The average annual precipitation is 17 to 20 inches, and the mean annual temperature is about 46 degrees F.

Typical pedon of Springdale gravelly sandy loam, 0 to 7 percent slopes, 1,300 feet south and 1,240 feet east of the northwest corner of sec. 21, T. 27 N., R. 39 E.

A11-0 to 3 inches; grayish brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; 20 percent pebbles; slightly acid; abrupt smooth boundary.

A12-3 to 9 inches; brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common roots; few fine and many very fine pores; 20 percent pebbles; neutral; clear smooth boundary.

C1-9 to 17 inches; pale brown (10YR 6/3) very gravelly loamy coarse sand; dark brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few roots; many very fine pores; 30 percent pebbles, 10 percent cobbles; neutral; gradual smooth boundary.

C2-17 to 24 inches; pale brown (10YR 6/3) very gravelly loamy coarse sand, dark brown (10YR 4/3) moist; massive; hard, friable, nonsticky and nonplastic; few roots; many very fine pores; 30 percent pebbles, 10 percent cobbles; neutral; clear smooth boundary.

C3-24 to 60 inches; multicolored very gravelly sand; single grain; loose; few roots; neutral; 30 percent gravel, 20 percent cobbles.

The control section is 35 to 60 percent coarse fragments. These soils are usually moist but for 75 to 90 consecutive days are dry in all parts between depths of 12 and 35 inches.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 1 or 2, dry or moist. It is gravelly and cobbly.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 2 or 3. It has weak fine subangular or weak fine granular structure. It is very gravelly sandy loam, very gravelly coarse sandy loam, or very gravelly loamy sand underlain by coarse sand or by loamy coarse sand that is very gravelly.

Starbuck series

The Starbuck series consists of shallow, well drained soils that formed in loess over basalt. These soils are on basalt plateaus along major drainageways. The elevation is 1,400 to 2,000 feet. The slope is 0 to 20 percent. The average annual precipitation is 8 to 12 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Starbuck cobbly silt loam, 0 to 20 percent slopes, 860 feet east and 2,100 feet north of the southwest corner of sec. 13, T. 22 N., R. 35 E.

A1-0 to 9 inches; brown (10YR 5/3) cobbly silt loam, dark brown (10YR 3/3) moist; weak medium granular and weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots to a depth of 3 inches, common roots below; many fine pores; 20 percent cobbles; neutral; clear smooth boundary.

B2-9 to 15 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 3/4) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; common very fine and few coarse pores; 10 percent pebbles, 5 percent cobbles; neutral; abrupt wavy boundary.

R-15 inches; basalt.

The depth to bedrock and the thickness of the solum are 12 to 20 inches. The control section averages 5 to 30 percent angular fragments of basalt. These soils are usually dry in all parts below a depth of 8 inches. The reaction is neutral to mildly alkaline.

The A horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is 0.5 to 1.0 percent organic matter and 15 to 35 percent coarse fragments.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is fine sandy loam, loam, or silt loam.

Strat series

The Strat series consists of very deep, well drained soils. These soils are on outwash plains and terrace escarpments. They formed in glacial outwash that is

mixed with loess in the upper part. The elevation is 1,300 to 1,700 feet. The slope is 3 to 25 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Strat very cobbly silt loam, 3 to 25 percent slopes, 1,320 feet east and 1,120 feet south of the northwest corner of sec. 6, T. 21 N., R. 34 E.

A1-0 to 9 inches; brown (10YR 5/3) very cobbly silt loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common very fine pores; 20 percent cobbles, 20 percent pebbles; mildly alkaline; abrupt smooth boundary.

B2-9 to 22 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; 10 percent cobbles, 40 percent pebbles; moderately alkaline; clear wavy boundary.

IIC-22 to 60 inches; multicolored extremely gravelly coarse sand; 10 percent cobbles, 70 percent pebbles; single grain; loose; moderately alkaline.

Loamy coarse sand and gravel are at a depth of more than 20 inches. The control section averages 35 to 75 percent coarse fragments, 40 to 60 percent sand, and 7 to 12 percent clay. These soils are usually dry at a depth of 4 to 12 inches.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 2 or 3, dry or moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is silt loam or loam and is very gravelly or very cobbly.

The C horizon is extremely gravelly and very gravelly.

Stratford series

The Stratford series consists of very deep, well drained soils. These soils are on outwash plains and terraces. They formed in glacial outwash that is mixed with loess in the upper part. The elevation is 1,300 to 1,700 feet. The slope is 0 to 15 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Stratford gravelly silt loam, 0 to 15 percent slopes, 1,200 feet east and 1,440 feet south of the northwest corner of sec. 12, T. 21 N., R. 33 E.

A11-0 to 2 inches; grayish brown (10YR 5/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; 5 percent cobbles, 15 percent pebbles; neutral; abrupt smooth boundary.

A12-2 to 8 inches; brown (10YR 5/3) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine and weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many roots; common fine pores; 5 percent cobbles, 15 percent pebbles; neutral; clear wavy boundary.

B2-8 to 13 inches; yellowish brown (10YR 5/4) gravelly silt loam, dark brown (10YR 3/3) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common roots; common fine pores; 20 percent pebbles; neutral; clear smooth boundary.

C1-13 to 24 inches; yellowish brown (10YR 5/4) gravelly loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common roots; common fine pores; 2 percent cobbles, 20 percent pebbles; neutral; clear smooth boundary.

IIC2-24 to 60 inches; extremely gravelly coarse sand; single grain; loose; 60 percent pebbles, 5 percent cobbles; silica on underside of gravel; moderately alkaline.

The extremely gravelly coarse sand is at a depth of 22 to 36 inches. The solum is 12 to 21 inches thick. The control section is 20 to 30 percent coarse fragments in the upper part and 40 to 75 percent coarse fragments in the lower part. These soils are usually dry between depths of 4 and 12 inches.

The A horizon has value of 4 or 5, dry, and chroma of 2 or 3, dry or moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist. It is gravelly silt loam or gravelly loam.

The C horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist. It is gravelly loam or very gravelly loam. The IIC horizon is mildly alkaline or moderately alkaline.

Tucannon series

The Tucannon series consists of moderately deep, well drained soils. These soils formed in loess and residuum of basalt on plateaus. The elevation is 1,900 to 2,300 feet. The slope is 0 to 15 percent. The average annual precipitation is 16 to 18 inches, and the mean annual temperature is about 50 degrees F.

Typical pedon of Tucannon silt loam, 0 to 5 percent slopes, 1,900 feet north and 940 feet west of the southeast corner of sec. 4, T. 26 N., R. 37 E.

Ap-0 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many roots to a depth of 3 inches, common roots to a depth of 10 inches; many very fine pores; neutral; abrupt smooth boundary.

B21-10 to 22 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic;

common roots; many very fine and few fine pores; 5 percent pebbles; neutral; gradual smooth boundary.

B22-22 to 30 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; common roots; many very fine and few fine pores; 5 percent pebbles; neutral; abrupt wavy boundary.

IIR-30 inches; basalt.

The thickness of the solum and the depth to basalt are 20 to 40 inches. The mollic epipedon is 20 to 30 inches thick. These soils are usually moist but for 70 to 80 consecutive days are dry in all parts between depths of 4 and 12 inches. The reaction is neutral or slightly acid.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist, and chroma of 1 or 2, dry or moist.

The B2 horizon has value of 4 or 5, dry, and 3 or 4, moist, and chroma of 2 or 3, dry or moist.

Willis series

The Willis series consists of moderately deep, well drained soils. These soils formed in calcareous loess on uplands. The elevation is 1,400 to 2,000 feet. The slope is 5 to 25 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Willis silt loam, 5 to 25 percent slopes, 240 feet west and 800 feet north of the southeast corner of sec. 35, T. 22 N., R. 33 E.

Ap-0 to 9 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; soft, very friable, slightly sticky and nonplastic; many fine roots; many very fine pores; mildly alkaline; abrupt smooth boundary.

B2-9 to 19 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common fine roots; many fine pores; mildly alkaline; clear wavy boundary.

C1ca-19 to 30 inches; pale brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, (10 percent very hard nodules), friable, slightly sticky and nonplastic; few fine roots; common fine pores; strongly alkaline; violently effervescent; clear smooth boundary.

C2simca-30 inches; light brownish gray (10YR 6/2) indurated lime-silica cemented hardpan, pale brown (10YR 6/3) moist; few light olive brown (2.5Y 5/4) mottles; massive; extremely hard, very firm, nonsticky and nonplastic; violently effervescent; strongly alkaline.

The lime-silica cemented hardpan is at a depth of 21 to 38 inches. The solum is 15 to 26 inches thick. The mollic epipedon is 9 to 15 inches thick. These soils are usually dry in all parts between depths of 4 and 12 inches for 90 consecutive days following the summer solstice. Fragments of the lime-silica hardpan are common throughout the profile. The reaction is strongly alkaline and mildly alkaline.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The B2 horizon has value of 5 or 6, dry, and 3 or 4, moist, and chroma of 3 or 4, dry or moist.

The Cca and Csim horizons have value of 6 through 8, dry, and 5 or 6, moist, and chroma of 2 or 3 through 4, dry or moist.

Willis Variant

The Willis Variant consists of shallow, well drained soils. These soils formed in calcareous loess on uplands. The elevation is 1,400 to 2,000 feet. The slope is 5 to 25 percent. The average annual precipitation is 9 to 12 inches, and the mean annual temperature is about 49 degrees F.

Typical pedon of Willis Variant silt loam, 5 to 25 percent slopes, 540 feet east and 60 feet south of the northwest corner of sec. 4, T. 24 N., R. 32 E.

Ap-0 to 12 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine pores; slightly effervescent; strongly alkaline; abrupt smooth boundary.

Csimca-12 to 15 inches; light gray (10YR 7/2) lime-silica cemented hardpan, pale brown (10YR 6/3) moist; massive; extremely hard, very firm; violently effervescent; strongly alkaline; abrupt smooth boundary.

C2ca-15 to 36 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine pores; violently effervescent; strongly alkaline; gradual wavy boundary.

C3ca-36 to 60 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; slightly effervescent; strongly alkaline.

The lime-silica cemented hardpan is at a depth of 8 to 16 inches. These soils are usually dry in all parts between depths of 4 and 12 inches for 90 consecutive days following the summer solstice. The surface layer is calcareous.

The A horizon has value of 4 or 5, dry, and 2 or 3, moist.

The Csimca horizon has value of 6 through 8, dry, and 4 through 6, moist, and chroma of 2 through 4, dry or moist.

formation of the soils

The properties of a soil are determined by the interaction of five factors: (1) parent material, (2) climate, (3) topography, (4) living organisms, and (5) time. These factors, as they occur in Lincoln County, are described in the following paragraphs.

parent material

The soils in Lincoln County formed mainly in loess, glacial outwash, volcanic ash, colluvium, alluvium, and weathered acid igneous rock.

Loess is a sediment, generally nonstratified, that has been deposited by wind. It is high in silt, low in clay, and generally has more than 70 percent base saturation. The loess probably originated as glacial flour deposited by melting glaciers during the Pleistocene Epoch. The prevailing southwest winds deposited the silt and clay particles across Lincoln County. The loess ranges in thickness from a few inches to several hundred feet. The thickest deposit, generally referred to as the "Palouse Formation," was covered by less compact loess. The present topography formed as the loess was eroded. The Bagdad, Hanning, Renslow, Ritzville, and Shano soils are examples of soils formed in the deepest layers of loess, which are on uplands.

Many of the soils in Lincoln County formed in glacial outwash sand and gravel. These soils are in the channeled scablands, which probably formed during the Pleistocene, when the ice dam that created Lake Missoula broke (3). The volume of water behind the dam is estimated to have been 500 cubic miles, and the depth at the dam is estimated to have been 2,000 feet. When the dam broke, it emptied in approximately two weeks. This surge of water was responsible for the creation of the channels, undrained basins, cataracts, loess islands, bars, and giant ripples that characterize the scablands. Seven similar ice dams were created. Five of these discharged water across Lincoln County in a southwest-northeast direction. The loess islands attest to the thickness of the loess at the time the dam burst. The material all around the islands was removed and deposited in places as glacial outwash.

Deposits of volcanic ash vary from a few inches to several feet in thickness. Thick deposits are in depressions and basins in the channeled scablands. The ash came from Mount Mazama, which erupted about 6,600 years ago. Most of the soils in the county are influenced by the ash. Emdent and Pedigo soils are examples of soils in basins that are high in content of volcanic ash.

A mixture of loess and colluvium that derived from basalt is the parent material in the deep canyons cut by the Columbia and Spokane Rivers. The Badge and Spiegle soils formed in this material.

Glacial outwash deposited by streamflow makes up the parent material on the terraces along the Columbia and Spokane Rivers. In places, the sand has been worked into a dune-like relief by the wind. The Ewall and Springdale soils are examples of soils that formed in glacial outwash material deposited by streams.

Some of the soils in the county formed in weathered acid igneous rock and an overlying layer of loess. Spokane and Dragoon soils are examples of soils that formed in weathered granite and the overlying loess.

Recent alluvium is the main parent material along drainageways of the uplands. These sediments are derived from rill erosion of the loess on the uplands. Esquatzel, Onyx, and Mondovi soils are examples of soils that formed in recent alluvium.

climate

Temperature and moisture control the rate at which minerals are weathered and removed from the soil profile. They also influence the depth at which soluble material is precipitated. They also influence the amount and kind of vegetation that grows.

The mean annual air temperature in the county ranges from 46.6 degrees F in the northeast to 49.2 degrees F in the southwest. Drought in summer and cold in winter slow the soil forming processes. Therefore, most of the soils in Lincoln County are considered young in geological age.

The average annual precipitation in the county ranges from 20 inches in the northeast to 8 inches in the southwest. Precipitation is lowest in summer, gradually increases in fall, and reaches a peak of slightly over 2 inches per month in winter. It decreases in spring and drops sharply in July. Warm (chinook) winds, accompanied by rain, often cause rapid melting of snow. If the ground is frozen, much of the meltwater is lost by runoff.

The depth to soft carbonates is directly related to the amount of annual precipitation. The depth to soft powdery lime in areas of low annual precipitation is only 20 to 40 inches. The Shano and Ritzville soils are

examples of soils that are shallow to the lime. In areas of greater annual precipitation the depth to soft powdery lime is greater. In places, areas of the Hanning soils for example, the depth to the lime is 60 inches or more.

Likewise, the greater the annual precipitation, the thicker the organic matter in the profile. An increase in moisture increases plant growth, thereby increasing the quantity of plant remains returned to the soil.

topography

The topography of Lincoln County ranges from basins or depressions in the channeled scablands to very steep canyons along the Columbia and Spokane Rivers.

Topography influences soil formation by its effects on drainage and runoff. Water falling on a level surface of permeable soil material will be absorbed uniformly until soil becomes saturated and then will collect on the surface and form ponds. On moderate or steep slopes, less water will penetrate the soil because of runoff. The soils on these positions are subject to more erosion, are generally less developed, and support less vegetation than the soils on level positions. In depressions or basins, the accumulation of water is greater than that on the level areas. The greater the amount of water that enters the soil, the greater the depth to which the soil is weathered. The water held by basins or depressions affects the color of soils. The Cocolalla soils, for example, are gray because they are saturated with water much of the time.

Aspect as well as slope can influence the characteristics of a soil. For example, lime is leached to a greater depth on a north-facing slope than on a south-facing slope because the north-facing slope is exposed to drifting snow and, therefore, receives more moisture.

living organisms

Plants and animals contribute to soil development mainly by furnishing organic matter and by bringing plant nutrients from the lower layers to the upper ones. The decay of roots and plant remains provides large amounts of organic material. Worms eat the organic material and mix it with the mineral soil material. Organic matter provides nutrients for plant growth, improves the water infiltration rate, improves the available water capacity of the soil, and reduces surface erosion by providing adequate plant cover.

Most of Lincoln County was covered with bunchgrass and sagebrush. Man has changed the vegetative cover by plowing the grassland and planting wheat. Some areas of wheat do not provide enough surface cover to reduce erosion. A decrease in the content of organic matter in the soil and accelerated erosion are evidence of man's influence on soil formation.

time

Time is necessary for the development of soil from parent material. Generally, the older the soil the more developed its horizons. Most of the soils in Lincoln County do not have strongly developed horizons.

In most of the county, the soil forming processes have been active for about 9,000 years; that is, since the last glaciation. In that time, loess and volcanic ash have been deposited. The latest deposit of volcanic ash was about 6,600 years ago. The deposition rate for loess is about 1 inch per 100 years.

The Esquatzel, Onyx, and Mondovi soils, which formed in recent alluvium, are examples of young soils. They have no strongly expressed horizons. The Reardan and Broadax soils are examples of older soils or remnants of older soils because of their strongly developed subsoils.

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. In 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Bretz, J. Harlan. 1959. Washington's channeled scabland. Div. Mines and Geol. Bull. No. 45, 57 pp., illus.

(4) Kaatz, Martin R. 1959. Patterned ground in central Washington. Northwest Sci., Vol. 33, No. 4, pp. 145-156, illus.

(5) Krauss, Hans A. 1978. The decline in yield over time in the Palouse Region of Washington State.

(6) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(7) United States Department of Agriculture. 1961. Yield of even-aged stands of ponderosa pine. Forest Serv. Tech. Bull. 630, 59 pp., illus.

(8) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil. Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Basalt. A dark, dense igneous rock of a lava-flow or minor intrusion. It is composed essentially of labrodorite and pyroxene and often has columnar structure.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Bulk density. The number of times heavier the dry soil is than water that will occupy the same volume.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Channeled scablands. An anastomotic drainage pattern resulting from successive glacial floods.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are1

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material. Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Culmination of the mean annual increment. The average yearly volume growth of a stand of trees from the year of origin to that age which gives the highest average.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming. A farming system in which the slope is divided into strips and crops are planted on alternate strips. On the other strips the soil is maintained in a condition that reduces water erosion.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained -Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained-Water is removed so slowly that the soil is saturated periodically during the growing season or remains, wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.-An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.-The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. A method of irrigation is-

Sprinkler. -Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Munsell notation. A designation of color by degrees of the three simple variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity Index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Riparian. Pertaining to the bank of a river or other body of water.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 100 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified

size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless soils* are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control' weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 100 inches (10 to 25 centimeters). Frequently designated as the 'plow layer,' or the 'Ap horizon.'

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.